A PRACTICAL ARITHMETIC

STEVENS

BUTLER

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BY

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PREFACE

THE primary object of arithmetic is to enable the student to acquire skill in computation. In addition to the attainment of this essential end, great benefit is derived from the exercise of the reasoning powers and their consequent development. While the first of these must ever remain the fundamental reason for the study of arithmetic, and the second will always be held in high esteem, there is a third major object which the teaching of arithmetic may accomplish, one which is usually almost entirely ignored in the preparation of an arithmetic; namely, the incidental teaching of valuable facts by basing the problems of the book upon the problems of real life.

In the preparation of this book, it has been the aim of the authors to secure the maximum results in these three functions of arithmetic teaching.

It is chiefly in the careful consideration which has been given to the subject-matter of the problems, and to the inferences that will unconsciously and unavoidably remain in the mind of the pupil, that this book differs from other arithmetics.

Skill in computation comes from learning a few methods, followed by extensive drill or practice. Methods have been carefully and clearly presented in this book, and an abundance of drill problems provided.

The development of the reasoning powers comes from work with problems requiring careful analysis before proceeding to the more mechanical solution. A large number

of carefully graded thought problems, necessitating accurate analysis, serves this end.

The special value of this book, however, depends upon the fact that a large proportion of its problems bring out clearly in their statement or in their solution important facts bearing upon the practical activities of life. Since agriculture is the one fundamental industry of America, especial attention has been given to this subject, and a large proportion of the thought problems are based upon agriculture, without, however, in any way leading to neglect of other industries.

The problems relating to agriculture are based upon wholly reliable information, upon the most recent findings of the State Experiment Stations and of the National Department of Agriculture. The facts used in these problems and the legitimate inferences which may be drawn from them are trustworthy. In solving these problems, the pupil will unconsciously absorb and retain many valuable facts and principles relating to agricultural practice, such, for example, as the value of seed selection, purity and vitality, judicious use of fertilizers, balancing of animal rations, crop rotation, prevention or treatment for plant diseases, conservation of soil moisture, preservation of soil fertility, prevention of insect injury, economy in methods of harvesting, proper dairy methods, the improvement of the herd by selection, poultry culture, value of good roads, etc.

A feature of value is the outline problems to be completed by the pupils with data from their homes.

Teachers, parents and pupils are invited to write to the authors of this book for information upon any agricultural points involved.

THE AUTHORS.

RALEIGH, N.C., November, 1908.

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PRACTICAL ARITHMETIC

NOTATION AND NUMERATION

EXERCISE 1.—ORAL

1. How many ones in 2, 8, 9?
2. How many tens in 20, 30, 50?
3. How many tens and ones in 18, 36, 45, 47, 98?
4. How many one hundreds in 200, 400, 600, 900?
5. How many one hundreds, tens, and ones in:

876	425	743	437	982
123	896	456	847	225
378	549	874	953	629

6. How many one hundreds in this number, 1000?
7. What name is given to this number?
8. How many thousands, hundreds, tens, and ones in:

6387	4702	6512	5068	6728
7080	1400	8150	6740	4963
8824	1814	3096	2263	9184

9. How many thousands in this number, 10000?
10. How many ten-thousands, thousands, hundreds, tens, and ones in:

50207	34291	23845	10205	23814
35842	78354	91846	35841	87961
26459	52796	87964	88249	18462

11. How many thousands in this number, 100000?

12. How many hundred-thousands, ten-thousands, thousands, hundreds, tens, and ones in:

259132	271186	350006	495271	468796
660878	504001	116006	203841	398178
802136	275360	275253	134410	884192

1. Hundreds, tens, and ones written together form a group or period, called **Units' Period.**

2. Hundred-thousands, ten-thousands, and thousands written together form a period, called **Thousands' Period.**

3. The next period higher than thousands' period is called **Millions' Period**; the next higher, **Billions' Period,** and the next **Trillions' Period**; but rarely is there use for these larger numbers.

4. The following diagram will aid in reading large numbers. Read the numbers given:

NAMES OF PERIODS:	TRILLIONS	BILLIONS	MILLIONS	THOUSANDS	UNITS
PERIODS:	5th Period	4th Period	3d Period	2d Period	1st Period
ORDERS:	hundreds tens units	hundreds tens units	hundreds tens units	hundreds tens units	hundreds tens units
	0 0 0	0 0 0	0 0 0	1 2 9	6 5 4
	0 0 0	0 0 0	0 0 4	2 0 1	2 5 0
	0 0 0	0 0 0	0 2 0	0 4 5	6 0 0
	0 2 0	0 0 6	3 0 2	4 6 3	0 0 1
	2 0 4	8 7 5	0 0 1	6 0 9	4 5 1

5. Numbers of more than four figures are usually written with a comma between the periods, thus:

1,642,001 63,105,005 78,121

6. To read a number. Begin at the right and point off into periods of three figures each; then begin at the left and read each period as if it stood alone, adding the name of the period.

7. The place value of a figure. What effect does it have upon the value of a figure to move it one place to the left in its period? To move it one place to the right?

Moving a figure one place to the left increases its value tenfold. Moving a figure one place to the right decreases its value tenfold.

EXERCISE 2.—ORAL

The Meaning of Numbers

There are 5 people in my neighbor's home: father, mother, daughter, and 2 sons. In 20 such homes there would be 100 people. In a small village of 100 homes there are about 500 inhabitants. Ten times as many people as this in one community would be 5000, and in 100 such towns together there would be 500,000 people.

The following numbers show the population of some capital cities in 1900. Read the numbers and try to realize their meaning:

1.	Albany,	94,151	3.	Richmond,	85,050
2.	Harrisburg,	50,167	4.	Trenton,	73,307

5.	Dover,	3,329	15.	Jefferson City,	9,664
6.	Baltimore,	508,957	16.	Madison,	19,164
7.	Augusta,	39,441	17.	Lansing,	16,485
8.	Boston,	560,892	18.	Columbus,	125,560
9.	Concord,	19,632	19.	Springfield,	34,157
10.	Providence,	175,597	20.	Raleigh,	13,643
11.	Bismarck,	3,319	21.	Jackson,	7,816
12.	Pierre,	2,305	22.	Tallahassee,	2,981
13.	Lincoln,	40,167	23.	Phœnix,	5,544
14.	St. Paul,	163,065	24.	Atlanta,	89,872

Read the following numbers, which express the corn and wheat produced and the number of milk cows of certain states in 1906:

		Corn, Bushels	Wheat, Bushels	Milk Cows
25.	North Carolina,	41,796,846	5,297,028	282,600
26.	New York,	22,685,000	9,350,180	1,826,211
27.	Georgia,	52,066,596	3,161,070	305,469
28.	Ohio,	141,645,000	43,202,100	919,100
29.	Mississippi,	40,789,207	17,610	329,664
30.	Iowa,	373,275,000	9,212,218	1,555,300
31.	Texas,	155,804,782	14,126,186	993,122
32.	Kansas,	195,075,000	81,830,611	729,274

8. Any one thing is called a **Unit.**

9. A unit or collection of units is called a **Number.**

10. Numbers representing whole units are called **Whole Numbers, Integral Numbers,** or **Integers.**

11. **Figures** or **Digits** are symbols used to express numbers.

12. The process of reading numbers is called **Numeration.**

13. Numbers may be expressed by **Figures, Letters,** or **Words.**

EXERCISE 3.—WRITTEN

Write these numbers in figures, using the comma to separate periods:

1. Six hundred seventy-five.
2. Two hundred thirteen.
3. Four hundred ninety-six.
4. Two hundred twenty-nine.
5. Four hundred eight.
6. One thousand, three hundred fifty-two.
7. Six thousand, forty.
8. Eighty thousand, eighty.
9. Seven thousand, three hundred.
10. Thirteen thousand, four hundred fifty.
11. Ninety-nine thousand, nine.
12. Forty-four thousand, sixteen.
13. Four hundred six thousand, one hundred fifty.
14. Three thousand, fourteen.
15. Nine thousand, seventy-seven.
16. Fifty thousand, sixty-eight.
17. Eleven thousand, nine hundred seventy-three.
18. Seven hundred eighty-five thousand, two.

19. Ninety-two thousand, one hundred six.

20. One million, three hundred ninety-seven thousand.

21. Eight thousand, four hundred eighty-two.

22. Nineteen million, one hundred fifty-six thousand.

23. Eight million, six.

24. Five thousand, one hundred thirty-one.

25. Sixty-three million, sixty-eight thousand, seven.

14. The art of writing numbers is called **Notation.**

EXERCISE 4. — WRITTEN

Write in figures the following numbers, which express the wool production and the number of hogs in several states, arranging in columns and using the comma between the periods, as in Exercise 2.

POUNDS OF WOOL PRODUCED IN 1906

1. North Carolina, eight hundred seventy-one thousand, two hundred fifty.

2. Alabama, five hundred sixty-eight thousand, seven hundred fifty.

3. Montana, thirty-five million, eight hundred fifteen thousand.

4. Florida, three hundred sixteen thousand, six hundred two.

5. Wyoming, thirty-two million, eight hundred forty-nine thousand, seven hundred fifty.

6. Texas, nine million, three hundred sixty thousand.

7. Missouri, four million, six hundred seven thousand, three.

NUMBER OF HOGS IN 1907

8. New York, six hundred seventy-five thousand, five hundred forty-five.

9. Iowa, eight million, five hundred eighty-four thousand, five hundred.

10. Pennsylvania, nine hundred eighty-nine thousand, six hundred eighty-five.

11. Kentucky, one million, two hundred thirteen thousand, three hundred eighty.

12. Illinois, four million, four hundred forty-nine thousand, seven hundred five.

13. Texas, two million, eight hundred sixty thousand, eight hundred seventy-nine.

14. Ohio, two million, four hundred thirty-six thousand, seven hundred ninety-seven.

15. Alabama, one million, two hundred fifty-one thousand, two hundred fifty-one.

16. Nebraska, four million, eighty thousand.

The following are the distances between several important cities. Write the numbers in figures and try to realize what they mean.

17. By rail from Albany, N.Y., to Troy, N.Y., six miles; from Utica, N.Y., to Rome, N.Y., fifteen miles; from Syracuse, N.Y., to Rochester, N.Y., eighty-one miles.

18. From St. Paul, Minn., to Portland, Ore., two thousand fifty-three miles; from Cleveland, O., to Cincinnati, O., two hundred sixty-three miles.

19. From Chattanooga, Tenn., to New Orleans, La., four hundred ninety-two miles; from Nashville, Tenn., to New Orleans, La., six hundred twenty-four miles; from New Orleans, La., to Atlanta, Ga., four hundred ninety-six miles.

STREET SCENE IN ATLANTA, GA.
From a photograph.
Copyright, 1907, by Underwood & Underwood.

20. By water from New York to Liverpool, three thousand fifty-eight miles; from San Francisco to Yokohama, four thousand, seven hundred ninety-one miles.

21. From New York to Manila, sixteen thousand, five hundred miles; from New York to Havana, one thousand, four hundred twenty miles.

22. From New York to Strait of Magellan, six thousand eight hundred ninety miles; from Strait of Magellan to San Francisco, six thousand one hundred ninety-nine miles.

23. By rail from New York to Omaha, one thousand three hundred eighty-five miles; to San Francisco, three thousand two hundred fifty miles.

24. The railroads of the United States aggregate one hundred ninety-three thousand miles, bearing thirty-eight thousand locomotives, fourteen thousand coaches, carrying yearly six hundred million passengers, and one billion tons of freight. They cost about five billion dollars.

ROMAN NOTATION

15. The system of notation and numeration already explained is commonly called the **Arabic System.** There is still another system known as the **Roman System.**

16. In the Roman system of notation seven capital letters of the alphabet and combinations of these letters are used to express numbers. The letters and their values are as follows:

I	V	X	L	C	D	M
1	5	10	50	100	500	1000

17. A bar placed over a letter increases its value a thousand fold, *e.g.*, $\overline{\text{V}}$ denotes 5000; $\overline{\text{X}}$ denotes 10,000.

18. When these symbols are used in combination their values are governed by the following laws:

I. Each repetition of a letter repeats its value, *e.g.*, XX denotes 20, XXX denotes 30, CC denotes 200, MMM denotes 3000.

II. When a letter is placed after one of greater value, its value is to be added to that of the preceding letter, *e.g.*, XI represents 10 and 1, or 11; VII represents 5 and 2, or 7; XVI represents 10 and 5 and 1, or 16; CXXI represents 100 and 10 and 10 and 1, or 121.

III. When a letter is placed before another of greater value, its value is taken from that of the letter of greater value, *e.g.*, IX represents 10 less 1, or 9; XL represents 50 less 10, or 40; XC represents 100 less 10, or 90.

IV. When a letter is placed between two letters of

greater value, its value is taken from that of the letter which follows it, *e.g.*, XIX represents 10 and 9, or 19; CXC represents 100 and 90, or 190.

EXERCISE 5. — WRITTEN

Express in Arabic notation:

1. XI	11. XXVII	21. MDLX
2. XX	12. XCV	22. MDXLVI
3. XIV	13. XLIV	23. MDCCXLIV
4. XXX	14. LXXIV	24. MMDCCXCIII
5. XL	15. CCLIV	25. $\overline{\text{V}}$CCCLXXVI
6. XVI	16. CDLVI	26. $\overline{\text{X}}$DCCXCIX
7. LV	17. DCIX	27. $\overline{\text{D}}$XLIV
8. LIX	18. MCXL	28. $\overline{\text{MD}}$CCLXXXIII
9. LXXVIII	19. MCXLV	29. $\overline{\text{MMCCC}}$CLXIV
10. XLIX	20. MDLIV	30. MMMDCCXIX

EXERCISE 6. — WRITTEN

Express in Roman notation:

1. 11	11. 98	21. 421
2. 17	12. 73	22. 943
3. 19	13. 116	23. 719
4. 42	14. 240	24. 1425
5. 33	15. 375	25. 1764
6. 12	16. 480	26. 5861
7. 26	17. 510	27. 24,854
8. 54	18. 450	28. 256,845
9. 83	19. 375	29. 1,450,819
10. 75	20. 741	30. 3,840,006

UNITED STATES MONEY

19. In the money of the United States the unit is the **Dollar.** In writing it is expressed by the sign $, *e.g.*, $25 is read twenty-five dollars.

20. Our money system is based upon the same system of tens and groups of tens which we studied in Arabic notation. That is, ten units of one order make a unit of the next higher order.

21. Ten ten-cent pieces equal one dollar. Ten one-cent pieces equal a ten-cent piece. A still smaller division of our money which we do not commonly use is called **Mills**. Ten mills equal one cent.

Ten cents is one-tenth of a dollar. One cent is one one-hundredth of a dollar. One mill is one one-thousandth of a dollar.

22. The period used to separate dollars and cents is called the **Decimal Point.**

23. The following diagrams serve to show the arrangement of dollars, cents, and mills as they are written:

	hundreds' dollars	tens' dollars	dollars	decimal point	tens' cents	cents	mills
$	2	4	5	.	2	4	5

	hundreds	tens	units	decimal point	tenths	hundredths	thousandths
$	2	4	5	.	2	4	5

EXERCISE 7.—ORAL

Read as dollars and cents:

1. $ 3.24	5. $ 25.06	9. $349.99	13. $ 542.89
2. $ 8.72	6. $ 91.07	10. $698.42	14. $ 560.90
3. $ 9.87	7. $ 92.09	11. $100.10	15. $1845.24
4. $10.25	8. $900.09	12. $ 99.99	16. $6291.98

Read as dollars, cents, and mills:

17. $5.842	20. $ 17.001	23. $981.701	26. $699.764
18. $3.205	21. $ 70.070	24. $909.701	27. $263.809
19. $4.998	22. $191.672	25. $340.034	28. $ 89.617

EXERCISE 8.—WRITTEN

Express the following in figures, using the dollar sign and decimal point:

1. Twenty dollars and fifty cents; thirty-four dollars and five cents.

2. Eighteen dollars and thirty-five cents; ninety-five dollars and twenty cents; thirty-one dollars and sixty cents; one hundred twenty dollars and four cents.

3. One hundred dollars and ten cents; fifty-four dollars and nineteen cents; fifty-three dollars and fifty-five cents; nineteen dollars and ninety cents.

4. Eighty dollars and one cent, five mills; fifty dollars and fifty cents; three hundred dollars and six cents, one mill; four hundred thirty-three dollars and thirty-three cents.

5. Five hundred dollars and three-tenths; two hundred dollars and thirty-three hundredths; one hundred dollars and three hundred thirty-three thousandths.

ADDITION

24. The growth of an apple twig in 1905 was 4 inches and in 1906 it was 6 inches. How many inches did it grow in the two years?

Addition is the process of finding the number that is equal to two or more numbers taken together.

25. The result obtained by adding numbers is called the **Sum**.

26. The sign of addition, +, is called **Plus**. When placed between numbers it means that they are to be added.

27. The sign of equality, =, when placed between numbers shows that they are equal. Thus $7 + 3 = 10$ is read seven plus three equals ten.

28. Find the sums of the following, which include all the combinations of two numbers from one to nine:

$2 + 7 =$	$2 + 1 =$	$3 + 1 =$	$1 + 9 =$
$4 + 2 =$	$3 + 7 =$	$1 + 6 =$	$3 + 5 =$
$3 + 4 =$	$1 + 1 =$	$2 + 4 =$	$1 + 7 =$
$2 + 3 =$	$7 + 2 =$	$3 + 7 =$	$4 + 3 =$
$7 + 1 =$	$3 + 3 =$	$5 + 4 =$	$6 + 1 =$
$8 + 2 =$	$4 + 5 =$	$1 + 4 =$	$3 + 2 =$
$1 + 9 =$	$6 + 4 =$	$2 + 2 =$	$1 + 2 =$
$5 + 2 =$	$1 + 8 =$	$5 + 5 =$	$4 + 6 =$
$3 + 6 =$	$2 + 5 =$	$8 + 1 =$	$6 + 2 =$

$6+3=$	$4+4=$	$2+8=$	$1+3=$
$5+3=$	$2+6=$	$3+4=$	$4+1=$
$1+5=$			

Practise adding these numbers daily until the sum of any of these combinations can be told at a glance.

EXERCISE 9.—ORAL

1. A man fed a colt 2 quarts of oats, a driving horse 4 quarts, and a draught horse 6 quarts. How many quarts of oats did he use at a feeding?

2. If the morning and the afternoon each becomes 5 minutes longer during the second week in March, how much longer are the days of the second week than the days of the first week?

3. If the cost of hauling Kansas wheat to the railroad station is 3 cts. a bushel, and the freight to New York is 11 cts. a bushel, what is the total cost of transportation?

4. A dairyman had 4 cows. One gave 5 quarts, one 7 quarts, one 8 quarts, and another 9 quarts of milk at a milking. How many quarts did all give at a milking?

5. A morning from sunrise to noon in September is 6 hours, and from noon to sunset is 6 hours. What is the total length of the day?

6. A ration for a cow is: corn and cob meal, 5 lbs.; cotton-seed meal, 4 lbs.; hay, 20 lbs. What is the weight of the entire ration?

7. The number of cloudy days in January was 9, the rainy days were 4. How many days were rainy and cloudy?

8. If a fruit cake requires 3 lbs. of currants, 2 lbs. of raisins, and 1 lb. of citron, how many pounds of fruit are used in the cake?

9. If the increase in temperature at Raleigh, N.C., in 1907 was 26 degrees from February to May and 14 degrees from May to August, what was the total increase in temperature during the six months?

10. If the temperature decreases 8 degrees from July to September and 33 degrees from September to March, what is the total decrease in temperature?

11. The number of senators from each of several sections of our country in 1890 was as follows: from the New England States, 12; the Middle States, 8; the Pacific States, 10. How many senators were there from all these sections?

12. The number of senators from the two largest sections of our country in 1890 was as follows: the South, 28; the Northwest, 24. How many senators were there from these seetions?

13. A ration for a cow is 15 lbs. of hay, 30 lbs. of silage, 4 lbs. of cotton-seed meal, 3 lbs. of wheat bran, and 3 lbs. of corn meal. What is the weight of the entire ration?

14. Count from 3 to 99 by threes.

15. Count from 4 to 100 by fours.

16. Count from 6 to 96 by sixes.

17. Count from 9 to 99 by nines.

18. At Raleigh, N.C., in 1907 the lowest temperature for the month of October was 36 degrees, the highest

temperature was 45 degrees higher. What was the highest temperature?

19. Two skilled laborers earned \$3 and \$5 respectively a day. How much did the two earn together?

20. Two unskilled laborers earned respectively \$1.25 and \$1.50 a day. How much did the two earn?

21. The cultivation of an acre of corn costs \$6, the fertilizers \$3, harvesting and other expenses \$3. What is the cost of the crop per acre?

22. A ration for a horse weighing 1000 lbs. when doing moderately hard work is 6 lbs. of corn, 8 lbs. of oats, and 15 lbs. of hay. What is the weight of the ration?

23. A ration for a fattening beef animal weighing 1000 lbs. is 30 lbs. of corn silage, 12 lbs. of corn stover, 5 lbs. of cotton-seed meal, and 4 lbs. of cotton seed. What is the weight of the ration?

24. If a man wishes to seed an acre for a meadow and uses 11 lbs. of timothy, 6 lbs. of red top, and 5 lbs. of clover seed, how many pounds of seed does he sow on the acre?

25. If 1000 lbs. of an average mixed stable manure contain 5 lbs. of nitrogen, 6 lbs. of potash, and 3 lbs. of phosphoric acid, how many pounds of these plant foods does it contain?

26. If the plants in a ton of dry clover hay used 39 lbs. of nitrogen, 37 lbs. of potash, and 11 lbs. of phosphoric acid in growth, how many pounds of these materials were used by the plants?

27. If a ton of wheat straw used in growing 11 lbs.

of nitrogen, 23 lbs. of potash, and 4 lbs. of phosphoric acid, how many pounds of these materials were taken from the soil?

28. If a ton of oat grain used in growing 35 lbs. of nitrogen, 9 lbs. of potash, and 13 lbs. of phosphoric acid, how many pounds of these materials were used?

EXERCISE 10. — WRITTEN

Find the sum of:

1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**
9	4	5	8	7	2	5	6
2	4	2	7	5	3	4	4
3	5	1	2	4	5	2	4
4	8	5	4	2	4	3	9
5	7	7	5	1	6	2	7

9.	**10.**	**11.**	**12.**	**13.**	**14.**	**15.**	**16.**
7	6	9	5	4	8	6	2
6	3	8	8	7	8	8	8
9	5	7	9	6	9	6	4
8	8	6	5	4	9	7	9
5	6	8	7	3	2	9	4
4	8	7	9	6	2	8	1

29. Add 259, 634, and 872.

$$\begin{array}{r} 259 \\ 634 \\ 872 \\ \hline 1765 \end{array}$$

The sum of the units' column is 15, or 5 units and 1 ten; the 5 representing units is written under the units' column. The sum of the tens' column + 1 ten carried from the first column is 16. The figure representing the 6 tens is placed under the tens' column, and the 1 representing hundreds is added with the hundreds'

column. The sum of the hundreds' column +1 from the tens' column is 17. The last sum is placed under the column added.

30. Rule for Addition. Write the numbers to be added so that the figures representing units stand under units, tens under tens, hundreds under hundreds, etc. Begin at the right and add each column separately, placing the sum underneath if it is less than ten. If the sum of any column exceeds nine, set down the right-hand figure and add the other figure or figures to the next column at the left.

EXERCISE 11. — WRITTEN

Add:

1.	2.	3.	4.	5.	6.
56	78	14	4	126	696
76	43	18	25	205	348
99	21	7	79	811	319
4	7	39	64	79	871
18	51	88	23	236	296
15	75	78	49	815	64
37	64	99	86	429	337

7.	8.	9.	10.	11.	12.
526	237	124	58	321	379
448	213	87	222	118	672
973	716	116	972	961	789
87	89	615	736	69	709
988	825	793	845	296	69
147	298	611	47	348	879
268	794	989	623	799	27

ADDITION OF UNITED STATES MONEY

31. Add $4.25, $16.50, $.45, $150, $3.455.

$4.25
16.50
.45
150.00
3.455
$174.655

Write the numbers to be added so that units of the same order shall stand in the same column, with the decimal points in a vertical line. Add as in integral numbers. The decimal point in the sum should stand directly in line with the decimal points of the numbers added.

EXERCISE 12. — WRITTEN

Add:

1.	2.	3.	4.
$2.50	$1.006	$340.006	$30.006
3.05	21.05	10.01	300.10
.90	3.425	62.62	106.001
.06	42.14	324.05	10.50
7.25	75.141	231.005	3.75

EXERCISE 13. — WRITTEN

1. Add: $3.05, $20.006, $45.25, $6.25, $3.755.
2. Add: $63.43, $25.002, $23.025, $300.45, $62.725.
3. Add: $90.93, $84.005, $2.005, $16.85, $4.35, $1.98.
4. Add: $63.05, $400.62, $50.50, $200.20, $3.75, $4.25.
5. Add: $50.005, $560.35, $428.72, $34.91, $863.100.
6. Add: $678.78, $67249.16, $9381.62, $862.98, $6798.98.

EXERCISE 14. — WRITTEN

Find the sum of:

1.	2.	3.	4.	5.
6314	6798	8569	7873	2361
7581	8347	7863	2578	5671
6384	6437	9088	5447	1983
2678	8089	8637	9138	3612
7896	1463	4475	7819	9278

6.	7.	8.	9.
$4798.75	$9862.79	$ 428.69	$7963.07
267.98	299.89	1796.99	629.67
495.12	4621.00	289.78	1198.79
490.07	7978.91	964.68	682.87
989.75	7842.29	629.29	298.
862.93	7096.07	729.62	391.09

Find the sum of:

10. 213, 14, 594, 672, 10, 756, 1875, 67.

11. 310, 64, 236, 79, 118, 296, 51, 9.

12. 716, 615, 1857, 9241, 19, 65, 452.

13. 463, 7, 8700, 1207, 1439, 4245, 5402.

14. $7.42, $28.75, $30.015, $500.00, $89.675, $620.908.

15. $62.50, $934.25, $245.63, $72.00, $786.21, $5.04.

16. $650.30, $12,645.32, $100.84, $100.084, $256.25.

17. 7,682,963, 842,981, 428,792, 6879, 84,289, 831.

18. 6,687,328, 64,298, 179,632, 281, 7, 698, 768,342.

19. 1,786,984, 6,827,341, 92,712, 863,298, 347,829.

20. $862.79, $9341.05, $67,294.73, $76,932.06.

21. 1,796,328, 6,297,348, 291, 7,283,409, 8624.

EXERCISE 15. — WRITTEN

The exports of cheese for 1901–1905 were:

COUNTRY	1901	1902	1903	1904	1905
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bulgaria . . .	6,449,020	5,651,335	7,064,385	6,624,517	7,227,816
Canada . . .	200,946,401	229,099,925	233,980,716	215,733,259	215,834,543
France	17,795,274	20,545,803	23,119,970	20,711,480	22,125,152
Germany . . .	3,211,693	3,119,981	2,813,539	2,597,927	2,650,397
Italy	24,104,455	28,841,967	33,158,617	30,299,443	37,694,647
Netherlands .	104,269,090	104,785,152	109,025,968	103,069,081	98,438,575
New Zealand .	11,680,928	8,371,552	8,375,360	9,466,912	9,918,944
Russia	1,610,414	1,655,230	1,406,557	1,396,951	1,119,497
Switzerland . .	60,075,729	54,491,422	53,642,863	56,688,989	61,383,731
United States .	27,203,184	18,987,178	23,335,172	10,134,424	16,562,451
Other countries	7,924,000	9,469,000	8,833,000	7,050,000	5,092,000

1–5. Find the total exports for each year.

6–16. Find the total exports from each country.

The pupil should add as many of the following problems as need be to attain speed and accuracy.

	a	*b*	*c*	*d*	*e*
1	86793	84928	76321	42894	78621
2	84697	68296	98988	86796	78629
3	17986	79826	42391	76842	68792
4	28649	78421	97632	49988	68499
5	99763	89792	88767	84921	69837
6	89798	66787	62849	76639	62897
7	56845	86283	32918	74289	88997
8	67632	97987	98999	77877	68298
9	74911	83172	64829	79638	28429
10	64523	68791	48796	42981	78429
11	69354	81786	86429	36827	64287
12	98732	88793	34287	42963	96832

17–21. Find the sum of columns *a*, *b*, *c*, *d*, *e*.

22–33. Find the sum of each line of numbers from 1 to 12 without copying.

34–47. Find the sums of the numbers in diagonal rows, thus: *b* 1, *a* 2, also *c* 1, *b* 2, *a* 3, and all other possible rows having the same direction, as *d* 1 to *a* 4, etc.

48–61. Similarly, find the sums of the numbers in diagonal rows *d* 1, *e* 2, also *c* 1, *d* 2, *e* 3, and by all other possible rows having the same direction.

EXERCISE 16. — WRITTEN

1. A dairyman has 6 cows. The first gives 18 lbs. of milk, the second 11 lbs., the third 23 lbs., the fourth 26 lbs., the fifth 32 lbs., the sixth 40 lbs. How much do they all give?

2. If a 200-lb. sack of fertilizer contains 8 lbs. of nitrogen, 10 lbs. of potash, and 16 lbs. of phosphoric acid, how many pounds of these plant foods are there in a sack?

3. If a reader costs 43 cts., a history 86 cts., an arithmetic 49 cts., a geography $1.08, a tablet 8 cts., pens and pencils 7 cts., what is the cost of the equipment?

4. In the stomach and crop of a bob-white there were found 400 pigweed seeds, in another 500 ragweed seeds, in another 550 sheep-sorrel seeds, in another 640 seeds of pigeon grass. How many of these weed seeds were consumed by these four bob-whites?

5. When thoroughly dry, the weight of the different parts of the cotton plants grown on an acre of land was as follows: lint 300 lbs., seed 507 lbs., bolls 363 lbs.,

leaves 566 lbs., roots 130 lbs., stems 604 lbs. What was the total weight of plants produced to yield 300 lbs. of lint cotton?

6. If the material grown on an acre in corn weighs as follows: ears 4325 lbs., stover, which consists of stalks, 2379 lbs., leaves 1190 lbs., and shucks 397 lbs., how much did the ears and stover together weigh? How much did the stover weigh?

7. A farmer sold the following products during the year: 1 horse $145, 9 beef animals $468, 18 hogs $234, 13 lambs $52, 309 bus. potatoes $126, 10 bales cotton $528, 150 bus. seed oats $75, 100 bus. seed corn $100, 50 chickens $22, 200 doz. eggs $38, 12 turkeys $21, 220 bus. wheat $191. To what did his total sales amount?

8. The different parts of the dressed carcass of a beef animal that, when alive, weighed 1550 lbs. weigh as follows: neck 40 lbs., chuck 237 lbs., prime ribs 117 lbs., porter-house steak 103 lbs., sirloin steak 87 lbs., rump 36 lbs., round steak 183 lbs., shank 30 lbs., flank, 52 lbs., ribs plate 138 lbs. What is the weight of the dressed carcass?

9. A New England cottage was built at a cost as follows: masonry $250, lumber and mill work $700, carpentering $400, plumbing $170, painting $90, hardware $20, heater, $200. What did the house cost when completed?

10. A cottage planned to cost $1000 was built for the following cost: foundation and brickwork $428.80, lumber $370.15, carpentering $264.87, painting and plaster-

ing $253.25, hardware $38.90, tin work, $13.78. What did the house actually cost?

11. A farm costing $5250 is equipped as follows: house $1579.42, farm mules $850.00, 1 horse $175.00, cattle $275.00, hogs $112.00, implements and tools $672.00. What is the total value of the farm and its equipment?

COST OF FURNISHING A HOUSE

Two young people equip their home with the following articles. Find the cost of each room separately.

12. KITCHEN: Linoleum, $20.00; range, $45.00; table, $1.50; chair, $1.00; utensils, $13.00; laundry outfit, $8.25; refrigerator, $21.00; lamp, 45 cts.; clock, $1.00; cutlery, 75 cts.

13. DINING ROOM: Table, $20.00; six chairs, $24.00; sideboard, $30.00; rug, $12.00; clock, $4.98; silence cloth, $1.25; lamp, $2.97; 3 dozen napkins, $9.48; 2 dozen napkins, $4.30; six table-cloths, $15.00; six plated knives, $4.50; six solid silver forks, $12.00; 12 solid silver spoons, $10.00; three tablespoons, $6.00; dishes, $15; glassware, $7.45.

14. LIVING ROOM: Lamp, $3.50; table, $15.00; Morris chair, $14.60; chair, $5.45; rattan chair, $9.25; arm-chair, $7.50; bookcase, $9.45; magazine stand, $6.25; rug, $34.50.

15. HALL: Lamp, $3.25; hall rack, $16.35; chair, $3.45; rug, $6.00.

16. BEDROOM: Bureau, $22.35; chiffonier, $11.25; washstand, $4.00; toilet set, $6.25; chair, $2.75; lamp,

$1.50; bed, $13.00; springs, $5.00; mattress, $15.00; 12 sheets, $9.60; 12 pillow cases, $5.00; 2 pairs blankets, $10.00; 1 comfortable, $1.00; 2 counterpanes, $3.45; 2 dozen towels, $6.00; 1 dozen yards toweling, $1.80; rug or matting, $5.80.

17. Find the total amount spent in furnishing the house.

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18. If a family of two persons spends for rent $130, food $210, clothing $80, fuel $30, light $6, insurance $24, replenishing $10, carfare $5, literature $5, charity $10, and saves $20, what is the income?

19. A second family of five persons spends for house rent $240, table expense $364, clothing $175, fuel $52, light $3, hired help $50, renewals $50, dentist $25, boys spending money $13, spending money of other children $5. What is the income?

20. What is the cost of raising an acre of corn, estimating rent at $3.03, fertilizer $1.86, preparation of the soil $1.62, planting $.42, cultivating $1.80, harvesting $3.00, and other expenses $1.76?

21. What is the total cost of raising an acre of upland cotton, allowing for the rent of land $3.25, fertilizer $2.46, preparing the soil $3.00, seed $.21, planting $.28, cultivating $2.31, picking $3.37, ginning and pressing $1.65, wear of tools $.62, marketing $.64, and other expenses $1.42?

22. A man owns 5 horses. The first is worth $90, the second $125, the third $175, the fourth as much as the first and second, the fifth as much as the second and fourth. What was the value of the 5 horses?

23. The number of miles of railroad in the world in 1900 was: North America 216,000, Europe 173,000, Asia 36,000, South America and West Indies 28,000, Australasia 15,000, Africa 12,000. What was the total mileage?

Alabama, S.	1,828,697
Arkansas, S.	1,311,564
California, P.	1,485,053
Colorado	539,700
Connecticut, N.E.	908,420
Delaware, M.	184,735
Florida, S.	528,542
Georgia, S.	2,216,331
Idaho	161,772
Illinois, E.C.	4,821,550
Indiana, E.C.	2,516,462
Iowa, W.C.	2,231,853
Kansas, W.C.	1,470,495
Kentucky, E.C.	2,147,174
Louisiana, S.	1,381,625
Maine, N. E.	694,466
Maryland, M.	1,188,044
Massachusetts, N.E.	2,805,346
Michigan, E.C.	2,420,982
Minnesota, W.C.	1,751,394
Mississippi, S.	1,551,270
Missouri, W.C.	3,106,665
Montana	243,329
Nebraska, W.C.	1,066,300
Nevada	42,335
New Hampshire, N.E.	411,588
New Jersey, M.	1,883,669
New York, M.	7,268,894
North Carolina, S.	1,893,810
North Dakota, W.C.	319,146
Ohio, E. C.	4,157,545
Oklahoma, S.	790,391
Oregon, P.	413,536
Pennsylvania, M.	6,302,115
Rhode Island, N.E.	428,556
South Carolina, S.	1,340,316
South Dakota, W.C.	401,570
Tennessee, S.	2,020,616
Texas, S.	3,048,710
Utah	276,749

The adjoining table gives the population of the States of the United States in 1900.

24. Find the population of the New England States, indicated by N.E.

25. Find the population of the Middle States, indicated by M.

26. Find the population of the Western Central States, indicated by W.C.

27. Find the population of the Southern States, indicated by S.

28. Find the population of the Pacific States, indicated by P.

Vermont, N.E.	343,641
Virginia, M.	1,854,184
Washington, P.	518,103
West Virginia, M.	958,800
Wisconsin, E.C.	2,069,042
Wyoming	92,531

29. Find the population of the Eastern Central States, indicated by E.C.

30. The remaining States are Plateau States. What is the population?

Except in leap year the days in the months number:

January	31
February	28
March	31
April	30
May	31
June	30
July	31
August	31
September	30
October	31
November	30
December	31

31. How many days are there in a year that is not a leap year?

32. The twenty-second of February is how many days after January first?

33. The fourth of July is how many days after January first?

34. The twenty-fifth of December is how many days after January first?

SOME IMPORTANT DATES

35. From the discovery of America by Columbus in 1492 to the founding of St. Augustine 73 years elapsed. From the founding of St. Augustine to the settlement of Jamestown 42 years elapsed. What were the dates of these two settlements?

36. From the discovery of America in 1492 to the founding of New Amsterdam 122 years elapsed. From the founding of New Amsterdam to the landing of the Pilgrims 6 years elapsed. What were the dates of these two settlements?

37. From the first General Assembly in 1681 to the first Colonial Congress 84 years elapsed. From the first Colonial Congress to the second Colonial Congress 9 years elapsed. What were the dates of these two Congresses?

SIGNING THE DECLARATION OF INDEPENDENCE

38. From the first General Assembly in 1681 to the Declaration of Independence 95 years elapsed. From the Declaration of Independence to the adoption of the Articles of Confederation 5 years elapsed. What were the dates of these two events?

39. From the first General Assembly in 1681 to the adoption of the Constitution 106 years elapsed. From the adoption of the Constitution to the election of the first President of the United States 2 years elapsed. What were the dates of these events?

SUBTRACTION

32. One dairy cow produces 9 pounds of butter in a week, another 5 pounds. How much more does one produce than the other?

The process of finding how much greater one number is than another, or finding the difference between two numbers, is called **Subtraction.**

33. The larger number, or the number from which another is subtracted, is called the **Minuend.**

34. The smaller number, or the number subtracted, is called the **Subtrahend.**

35. The result obtained in subtracting is called the **Remainder** or **Difference.**

36. The sign of subtraction, $-$, is called **Minus.** When it is placed between two numbers, it means that the second number is to be subtracted from the first, *e.g.*, $8 - 5 = 3$ is read, eight minus (less) five equals three.

EXERCISE 17.—ORAL

$1 - 1 =$	$2 - 2 =$	$3 - 3 =$
$2 - 1 =$	$3 - 2 =$	$4 - 3 =$
$3 - 1 =$	$4 - 2 =$	$5 - 3 =$
$4 - 1 =$	$5 - 2 =$	$6 - 3 =$
$5 - 1 =$	$6 - 2 =$	$7 - 3 =$
$6 - 1 =$	$7 - 2 =$	$8 - 3 =$

$7-1=$	$8-2=$	$9-3=$
$8-1=$	$9-2=$	$10-3=$
$9-1=$	$10-2=$	$11-3=$
$10-1=$	$11-2=$	$12-3=$
$4-4=$	$5-5=$	$6-6=$
$5-4=$	$6-5=$	$7-6=$
$6-4=$	$7-5=$	$8-6=$
$7-4=$	$8-5=$	$9-6=$
$8-4=$	$9-5=$	$10-6=$
$9-4=$	$10-5=$	$11-6=$
$10-4=$	$11-5=$	$12-6=$
$11-4=$	$12-5=$	$13-6=$
$12-4=$	$13-5=$	$14-6=$
$13-4=$	$14-5=$	$15-6=$
$7-7=$	$8-8=$	$9-9=$
$8-7=$	$9-8=$	$10-9=$
$9-7=$	$10-8=$	$11-9=$
$10-7=$	$11-8=$	$12-9=$
$11-7=$	$12-8=$	$13-9=$
$12-7=$	$13-8=$	$14-9=$
$13-7=$	$14-8=$	$15-9=$
$14-7=$	$15-8=$	$16-9=$
$15-7=$	$16-8=$	$17-9=$
$16-7=$	$17-8=$	$18-9=$

NOTE. This **subtraction table** should be thoroughly studied by each pupil, and drill should be continued until the answers can be given quickly and correctly.

EXERCISE 18. — ORAL

Practice subtracting these numbers until the differences can be told instantly.

	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	
1.	4 1	7 1	6 2	2 2	4 3	5 1	6 3	1 1	8 1	**1.**
2.	2 1	3 3	9 1	10 2	3 1	5 2	4 2	6 1	10 1	**2.**
3.	7 2	10 3	5 3	3 2	4 4	9 2	6 4	11 2	8 2	**3.**
4.	9 3	10 5	7 3	9 4	5 4	7 5	11 3	5 5	8 4	**4.**
5.	6 6	8 6	12 3	13 4	8 7	7 4	9 5	6 5	8 3	**5.**
6.	10 4	7 6	10 8	9 7	11 4	8 5	9 6	7 7	14 6	**6.**
7.	11 5	14 6	13 5	8 8	12 4	12 7	10 6	9 8	13 7	**7.**
8.	11 8	15 8	10 7	12 9	12 5	15 9	16 7	16 8	12 8	**8.**
9.	12 6	13 9	18 9	15 6	17 9	15 7	11 6	14 9	11 7	**9.**
10.	10 9	14 7	14 5	16 9	13 8	17 8	11 9	14 8	13 6	**10.**
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	

EXERCISE 19.—ORAL

1. If a twig grew 6 ins. in 1906, and 4 ins. in 1907, which year produced the greater growth? How much greater?

2. What number taken from 10 leaves 2?

3. What number with 6 makes 10?

4. If a strawberry plant has 12 leaves and 4 are injured by insects, how many sound leaves are there on the plant?

5. If a limb on the north side of a tree measures 9 ft., and one on the south side measures 11 ft., which is the longer? How much longer?

6. If the number of rainy and cloudy days in September were 17, how many clear days were there in September?

7. Subtract by threes from 99 to 0.

8. Subtract by fours from 100 to 0.

9. Subtract by sixes from 96 to 0.

10. Subtract by sevens from 98 to 0.

11. If the highest temperature for July in the Middle Atlantic States was 99 degrees, and the lowest temperature 57 degrees, what was the range in temperature?

12. The highest soil temperature at which wheat will grow is 104 degrees; squash and corn grow at 115 degrees. At how much higher temperature will squash and corn grow than wheat?

13. Melons grow best at a soil temperature of 99 degrees, and clover at 70 degrees. How much higher temperature is required for melons than clover?

14. The boiling point of water is 212 degrees, the freezing point 32 degrees. What is the difference in degrees between the boiling and freezing points?

15. A man wishes to start a small fruit garden. He has $15. to invest. The trellis and lattice cost $10. How much is left for the plants and trees?

16. If 2 pear trees cost 35 cts., 2 apple trees 25 cts., how much is left for smaller plants?

17. If 6 doz. strawberry plants cost 25 cts., and 4 raspberry plants cost $.25, how much is still left of the original sum?

18. A normal child 6 yrs. old weighs 45 lbs., measures 44 ins. in height, and has a chest measurement of 23 ins. A normal child of 9 yrs. weighs 60 lbs., measures 50 ins. in height, and has a chest measurement of 25 ins. What is the increase in weight in 3 yrs.?

19. What is the increase in height in 3 yrs.?

20. What is the increase in chest measurement in 3 yrs.?

37. From 875 take 446.

$$\begin{array}{r} 875 \\ \underline{446} \\ 429 \end{array}$$

Since we cannot take 6 units from 5 units we add one of the 7 tens to the 5 units, making 15 units. We now have 6 units to be subtracted from 15 units, which leaves 9 units to be written under the units' column. Since we have already taken 1 ten from the 7 tens we have 6 tens remaining in tens' column. 4 tens from 6 tens leaves 2 tens, which is written under tens' column; 4 hundreds from 8 hundreds leaves 4 hundreds. The remainder, therefore, is 4 hundreds, 2 tens, 9 units, or 429.

38. From 584 take 296.

$$\begin{array}{r} 584 \\ \underline{296} \\ 288 \end{array}$$

Since we cannot take 6 units from 4 units we must take one of the 8 tens, which added to 4 units makes 14 units. 6 units from 14 units leaves 8 units. Since we have already taken 1 ten from the 8 tens, we have 7 tens left. We cannot take 9 tens from 7 tens, so we must take 1 hundred from 5 hundreds, which added to 7 tens makes 17 tens. 9 tens from 17 tens leaves 8 tens. Since we have already taken 1 hundred from the 5 hundreds we have 4 hundreds left. 2 hundreds from 4 hundreds leaves 2 hundreds. The remainder, therefore, is 2 hundreds, 8 tens, 8 units, or 288.

39. Add the remainder to the subtrahend in each of the last two examples. What do you observe?

The sum of the remainder and the subtrahend is equal to the minuend. Hence, **to test the subtraction** add the remainder and subtrahend together. If the sum equals the minuend, the work is correct.

40. Rule for Subtraction. Write the subtrahend under the minuend, placing units under units and tens under tens, etc. Begin at the right and subtract each figure of the subtrahend from the corresponding figure of the minuend, and write the remainder underneath.

If any figure of the subtrahend is greater than the corresponding figure of the minuend, increase the figure of the minuend by taking one of the next higher order, which will be an increase of ten. Then diminish by 1 the order of the minuend from which the 1 was taken, and subtract.

EXERCISE 20. — WRITTEN

Subtract and prove:

1. 52 – 26. **2.** 37 – 28.

3. 94 – 58.
4. 93 – 25.
5. 92 – 68.
6. 81 – 18.
7. 70 – 36.
8. 90 – 27.
9. 50 – 13.
10. 95 – 47.
11. 786 – 235.
12. 598 – 213.
13. 647 – 238.
14. 321 – 216.
15. 976 – 247.
16. 876 – 381.
17. 358 – 149.
18. 467 – 248.

	a	*b*	*c*
1	18729	2628	278
2	28694	3979	379
3	39231	8642	428
4	47326	3981	471
5	22321	7986	879
6	32542	7842	642
7	73625	3765	839
8	39832	8429	341
9	32421	3764	768
10	31321	3428	429

The pupil should subtract sufficient of these problems to become accurate and rapid.

19–28. From the first number in column *b* take each number in column *c*.

29–118. From each other number in column *b* take each number in column *c*.

119–128. From the first number in column *a* take each number in column *b*.

129–218. From each other number in column *a* take each number in column *b*.

SUBTRACTION OF UNITED STATES MONEY

EXERCISE 21. — ORAL

Making Change

1. I buy a book for 42 cts.; how much change shall I receive from 50 cts.? Make change in two ways.

2. A yard of ribbon costs 12 cts., a spool of thread 5 cts., a paper of pins 5 cts. How much change do I receive from a fifty-cent piece? Make change in three ways.

3. A yard of silk costs 63 cts., 1 doz. buttons 10 cts., a bolt of tape 5 cts. Make change for $1 in two ways.

4. A copy of "Arabian Nights" costs $1.10. Make change for $2.00.

5. Make change for $2.00 when you owe $1.75; $.15.

6. Make change for $5.00 when you owe $1.49; $2.58.

7. Make change for $5.00 when you owe $3.18; $2.16.

8. Make change for $2.00 when you owe $1.23; $1.87.

9. A pair of shoes costs $2.25, hat $1.00, tie 50 cts., 4 handkerchiefs 72 cts. How much change does the merchant return for $5.00?

10. Make change for $10.00 when you owe $.81; $7.34.

41. Subtract $45.755 from $90.20.

$$\begin{array}{r} \$90.200 \\ 45.755 \\ \hline \$44.445 \end{array}$$

Since the subtrahend has mills and there are no mills in the minuend, a cipher is added to fill the place of mills. The subtrahend is written under the minuend so that units of the same order shall

stand in the same column, and the decimal points be in a vertical line. Subtract as integers. The decimal point in the remainder should stand directly under the decimal points of the minuend and subtrahend.

EXERCISE 22. — WRITTEN

Subtract and prove:

1. \$4.24 – \$1.10.	11. \$1.00 – \$.75.
2. \$3.86 – \$1.25.	12. \$11.00 – \$3.25.
3. \$4.50 – \$3.20.	13. \$90.99 – \$80.25.
4. \$10.75 – \$8.41.	14. \$77.42 – \$65.94.
5. \$6.54 – \$4.37.	15. \$93.20 – \$84.25.
6. \$9.27 – \$8.16.	16. \$525 – \$177.02.
7. \$12.50 – \$8.25.	17. \$197 – \$184.09.
8. \$17.28 – \$8.25.	18. \$3.333 – \$2.999.
9. \$18.24 – \$9.16.	19. \$16.725 – \$.50.
10. \$20.50 – \$10.25.	20. \$28.07 – \$.125.

EXERCISE 23. — WRITTEN

1. In a day's milking of 769 lbs. of milk from a herd of Jersey cows there are 661 lbs. of water, 69 lbs. of solids-not-fat, and the remainder is butter-fat. How many pounds of butter-fat in the day's milking?

2. In a day's milking of 769 lbs. from a herd of Holstein-Fresian cows there are 675 lbs. of water, 69 lbs. of solids-not-fat, and the remainder is butter-fat. How many pounds of butter-fat in the day's milking? How many pounds less of butter-fat than in problem 1?

3. The 3d of February 1907 is the 34th day of the

year; the 5th of June is the 156th day of the year. How many days between these dates?

4. The 10th of September is the 283d day of the year; the 10th of June is the 191st day of the year. What is the difference in dates?

5. The 22d of April is the 142d day of the year; the 31st of October is the 303d day of the year. What is the difference in dates?

6. Jamestown, Va., was settled in 1607; the Jamestown Exposition, near Norfolk, Va., occurred in 1907. How many years elapsed between the dates?

7. The boiling point of water is 212 degrees. Water is at simmering temperature at 180 degrees. What is the difference in temperature?

8. If a farmer kills a hog that weighs 369 lbs. when alive, how much will the dressed carcass weigh if it weighs 82 lbs. less than the live weight?

9. A butcher killed a beef animal of good quality that weighed 1148 lbs. and an inferior one that weighed 1179 lbs. What is the difference in the weight of the dressed carcasses of these beeves if the loss in weight of the first animal was 397 lbs. and of the second animal 529 lbs.?

10. If 4000 lbs. of ordinary fertilizer contains plant food as follows: phosphoric acid 320 lbs., nitrogen 80 lbs., and potash 80 lbs., how many pounds of plant food are there? How much that is not plant food?

11. In 4000 lbs. of cotton-seed hulls there are 444 lbs. of water and 2152 lbs. of indigestible matter. The remainder is digestible. How much is digestible?

12. In 4000 lbs. of corn there are 436 lbs. of water and 408 lbs. of indigestible matter. The remainder is digestible. How many pounds of digestible matter are there?

13. A man took 1500 lbs. of seed cotton to the gin and received a bale of lint weighing 493 lbs. How many pounds of seed should he also receive, all of the seed cotton that is not lint being seed?

14. If to cultivate an acre of corn costs $4.50, the fertilizers for it $3, harvesting $3.50, and other expenses $1.00, and 35 bus. of corn worth $17.50, and a ton and a quarter of stover worth $5, are produced, what is the farmer's profit?

15. If 1083 lbs. of cotton are harvested from a fertilized field planted with selected seed, and 670 lbs. are harvested from an unfertilized field where unselected seed was used, what is the increase in yield due to fertilization and seed selection?

16. To grow a ton of oats requires 464 tons of water. A ton of corn requires 271 tons, potatoes require 385 tons, and clover 577 tons. How much more water is required by potatoes than by corn? By clover than by oats? By clover than by corn? By clover than by potatoes? By oats than by corn? By oats than by potatoes?

17. If oat straw uses 163 lbs. of potash, 56 lbs. of nitrogen, and 28 lbs. of phosphoric acid, and oat grain uses 48 lbs. of potash, 176 lbs. of nitrogen, and 68 lbs. of phosphoric acid in every 10,000 lbs. of yield, which uses the most of each plant food, the straw or the grain? How much more of each?

18. In Michigan, soy beans with tubercles on their

roots yield 113 lbs. of nitrogen to the acre; without tubercles 76 lbs. of nitrogen to the acre. How many pounds' increase in nitrogen was there when the tubercles were present?

19. Cow-peas with tubercles on their roots yielded 139 lbs. of nitrogen and without tubercles 118 lbs. to the acre. What was the gain when tubercles were present?

20. A good clay soil contains 12,760 lbs. of potash, a good sandy soil 4840 lbs. of potash, to the acre, in a layer one foot deep. How much more potash is there in clay soil than in sandy soil per acre one foot deep?

HEIGHTS OF MOUNTAINS

The heights of some of the highest mountains are: Mt. Aconcagua 23,082 ft., Mt. Blanc 15,744 ft., Mt. Everest 29,002 ft., Mt. McKinley 20,464 ft., Mt. Mitchell 6711 ft.

21. Mt. Mitchell is the highest mountain in the eastern United States. How much higher is Mt. McKinley than Mt. Mitchell?

22. Mt. Aconcagua is the highest mountain in the Americas. How much higher is Mt. Everest than Mt. Aconcagua?

23. Mt. Blanc is the highest mountain in the Alps. How much higher is Mt. Everest than Mt. Blanc?

24. How much higher is Mt. Aconcagua than Mt. McKinley?

25. The greatest known depth of the ocean is 27,930 ft. How many feet less is this than the height of Mt. Everest?

MULTIPLICATION

42. If a blackbird destroys 3 cabbage worms in 1 hr., at the same rate how many cabbage worms will it destroy in 2 hrs.? In 3 hrs.? In 4 hrs.? In 5 hrs.? In 6 hrs.? In 7 hrs.?

3	3	3	3	3	3
3	3	3	3	3	3
	3	3	3	3	3
		3	3	3	3
			3	3	3
				3	3
					3
6	9	12	15	18	21

When several equal numbers are to be added, it is much shorter to obtain the result by the process known as **Multiplication.** To multiply, however, we must learn the sums of the most common numbers added to themselves definite numbers of times. Thus in the problem above we see that 3 taken 2 times gives 6, taken 3 times gives 9, etc.

43. The number to be repeated is called the **Multiplicand.**

44. The number which indicates how many times the multiplicand is to be repeated is called the **Multiplier.**

45. The result obtained by multiplying one number by another is called the **Product.**

46. The sign of multiplication is an inclined cross ×. When placed between two numbers it is read "times," or

"multiplied by." When the multiplier precedes the multiplicand with the multiplication sign $\times$ between them, the sign is read "times"; when the multiplicand precedes, the sign is read "multiplied by," *e.g.*, $3 \times 8 = 24$, is read 3 times 8 equals 24, or, regarding 8 as the multiplier, the expression is read, 3 multiplied by 8 equals 24.

47. A number that is applied to any particular object is called a **Concrete** number, *e.g.*, 1 bird, 3 caterpillars, 48 hrs.

48. A number that is not applied to a particular object is an **Abstract** number, *e.g.*, 1, 3, 48.

49. In multiplication the multiplier is always an abstract number.

50. The most useful products are shown in the following tables. They should be committed to memory.

$1 \times 1 = 1$	$1 \times 2 = 2$	$1 \times 3 = 3$
$2 \times 1 = 2$	$2 \times 2 = 4$	$2 \times 3 = 6$
$3 \times 1 = 3$	$3 \times 2 = 6$	$3 \times 3 = 9$
$4 \times 1 = 4$	$4 \times 2 = 8$	$4 \times 3 = 12$
$5 \times 1 = 5$	$5 \times 2 = 10$	$5 \times 3 = 15$
$6 \times 1 = 6$	$6 \times 2 = 12$	$6 \times 3 = 18$
$7 \times 1 = 7$	$7 \times 2 = 14$	$7 \times 3 = 21$
$8 \times 1 = 8$	$8 \times 2 = 16$	$8 \times 3 = 24$
$9 \times 1 = 9$	$9 \times 2 = 18$	$9 \times 3 = 27$
$10 \times 1 = 10$	$10 \times 2 = 20$	$10 \times 3 = 30$

$1 \times 4 = 4$	$1 \times 5 = 5$	$1 \times 6 = 6$
$2 \times 4 = 8$	$2 \times 5 = 10$	$2 \times 6 = 12$
$3 \times 4 = 12$	$3 \times 5 = 15$	$3 \times 6 = 18$
$4 \times 4 = 16$	$4 \times 5 = 20$	$4 \times 6 = 24$

$5 \times 4 = 20$	$5 \times 5 = 25$	$5 \times 6 = 30$
$6 \times 4 = 24$	$6 \times 5 = 30$	$6 \times 6 = 36$
$7 \times 4 = 28$	$7 \times 5 = 35$	$7 \times 6 = 42$
$8 \times 4 = 32$	$8 \times 5 = 40$	$8 \times 6 = 48$
$9 \times 4 = 36$	$9 \times 5 = 45$	$9 \times 6 = 54$
$10 \times 4 = 40$	$10 \times 5 = 50$	$10 \times 6 = 60$

$1 \times 7 = 7$	$1 \times 8 = 8$	$1 \times 9 = 9$
$2 \times 7 = 14$	$2 \times 8 = 16$	$2 \times 9 = 18$
$3 \times 7 = 21$	$3 \times 8 = 24$	$3 \times 9 = 27$
$4 \times 7 = 28$	$4 \times 8 = 32$	$4 \times 9 = 36$
$5 \times 7 = 35$	$5 \times 8 = 40$	$5 \times 9 = 45$
$6 \times 7 = 42$	$6 \times 8 = 48$	$6 \times 9 = 54$
$7 \times 7 = 49$	$7 \times 8 = 56$	$7 \times 9 = 63$
$8 \times 7 = 56$	$8 \times 8 = 64$	$8 \times 9 = 72$
$9 \times 7 = 63$	$9 \times 8 = 72$	$9 \times 9 = 81$
$10 \times 7 = 70$	$10 \times 8 = 80$	$10 \times 9 = 90$

$1 \times 10 = 10$	$1 \times 11 = 11$	$1 \times 12 = 12$
$2 \times 10 = 20$	$2 \times 11 = 22$	$2 \times 12 = 24$
$3 \times 10 = 30$	$3 \times 11 = 33$	$3 \times 12 = 36$
$4 \times 10 = 40$	$4 \times 11 = 44$	$4 \times 12 = 48$
$5 \times 10 = 50$	$5 \times 11 = 55$	$5 \times 12 = 60$
$6 \times 10 = 60$	$6 \times 11 = 66$	$6 \times 12 = 72$
$7 \times 10 = 70$	$7 \times 11 = 77$	$7 \times 12 = 84$
$8 \times 10 = 80$	$8 \times 11 = 88$	$8 \times 12 = 96$
$9 \times 10 = 90$	$9 \times 11 = 99$	$9 \times 12 = 108$
$10 \times 10 = 100$	$10 \times 11 = 110$	$10 \times 12 = 120$

EXERCISE 24.—ORAL

1. If it costs $6 to spray 1 acre of potatoes, how much will it cost to spray 8 acres?

2. If it costs $3 to harvest an acre of corn, how much will it cost to harvest 7 acres?

3. If 1 acre of corn produces 9 tons of silage, how many tons will 6 acres produce?

4. If it costs 4 cents an acre to treat seed oats to prevent oat smut, what will it cost to treat the seed for 8 acres?

5. If an acre of unfertilized land with unselected seed will produce 1 bale of cotton, how many bales will 9 acres produce?

6. If 1 acre of fertilized land with very carefully selected seed will produce 2 bales of cotton, how many bales will 9 acres produce?

7. At $50 a bale, what will be the value of the cotton in problem 5?

8. At $50 a bale, what will be the value of the cotton in problem 6?

9. A square field is 12 rods on a side. What is the distance around the field, or the perimeter?

10. If it takes 7 lbs. of ordinary seed corn to plant an acre, how many pounds will it take to plant 8 A.?

11. What is the cost of 6 tons of coal at $8 a ton?

12. If the school day is 5 hours long, how many school hours are there in a school week?

13. If a child sleeps 10 hours each night, how many hours does it sleep in 1 week?

14. If 10 hours are spent in sleep and 5 hours in school in each day of 24 hours, how many hours in a school week are left for play?

15. There are 12 inches in 1 foot. How many inches are there in 3 feet? What name is given to a measure 3 feet long?

16. If a man walks 3 miles an hour, how far will he go in 9 hours?

17. If a horse travels 6 miles an hour, how far will he go in 9 hours?

18. If a steamboat goes 9 miles an hour, how far will it go in 9 hours?

19. If a man on a bicycle rides 12 miles an hour, how far will he go in 9 hours?

20. If a freight train averages 15 miles an hour, how far will it go in 9 hours?

21. If an ocean liner goes 17 miles an hour, how far will it go in 9 hours?

22. If an automobile travels 20 miles an hour, how far will it go in 9 hours?

23. If an express train averages 35 miles an hour, how far will it go in 9 hours?

24. To properly cook a ham it should be kept at simmering heat 30 minutes for every pound of weight after first being plunged into boiling water and kept boiling for 10 minutes. How long will it take to cook a 9-lb. ham?

25. With spool cotton at 5 cents a spool or 50 cents a dozen, how many cents are gained by buying by the dozen rather than by the spool on a purchase of 5 dozen spools?

51. Find the product of 856×4.

Write the multiplier 4 under the multiplicand 856, placing the units of the multiplier under units of the multiplicand, and begin at the right to multiply.

$$\begin{array}{r} 856 \\ 4 \\ \hline 3424 \end{array}$$

$4 \times 6 = 24$. The 4 is written in units' column. The 2 tens are to be added to the product of tens. 4×5 tens $= 20$ tens. 20 tens plus the 2 tens, carried from the multiplication of units, gives 22 tens, or 2 hundreds and 2 tens. 2 tens is written under tens' column and 2 hundreds are to be added to hundreds' product. 4×8 hundreds $= 32$ hundreds, which with 2 hundreds makes 34 hundreds. 34 hundreds is written under hundreds' column. The product is 3424.

EXERCISE 25.—WRITTEN

Find the product of:

1. 2×365.
2. 4×197.
3. 3×754.
4. 5×863.
5. 7×189.
6. 6×275.
7. 4×986.
8. 5×184.
9. 7×689.
10. 8×173.
11. 9×602.
12. 3×456.
13. 6×629.
14. 8×371.
15. 7×864.
16. 9×298.
17. 3×672.
18. 3×1845.
19. 5×7543.
20. 6×1896.
21. 4×9806.
22. 3×5431.
23. 2×9864.
24. 4×1896.
25. 5×8652.
26. 8×6541.
27. 9×1864.
28. 8×8250.
29. 9×3475.
30. 4×8364.
31. 6×7928.
32. 3×6471.
33. 7×5498.
34. 9×3762.
35. $7 \times 37{,}863$.
36. $6 \times 31{,}245$.
37. $8 \times 43{,}036$.
38. $5 \times 68{,}734$.
39. $2 \times 81{,}896$.
40. $8 \times 52{,}783$.
41. $9 \times 28{,}357$.
42. $7 \times 48{,}021$.
43. $8 \times 52{,}163$.
44. $4 \times 59{,}136$.
45. $2 \times 24{,}386$.
46. $9 \times 12{,}854$.
47. $7 \times 47{,}829$.
48. $9 \times 79{,}836$.
49. $8 \times 64{,}281$.
50. $3 \times 97{,}645$.
51. $6 \times 58{,}792$.

52. What effect does it have upon a number to move it one place to the left in the period?

Moving a figure one place to the left has the same effect as multiplying it by 10, *e.g.*, $84 \times 10 = 840$.

To multiply by 10, place a cipher at the right of the multiplicand, thus moving each figure one place to the left and increasing its value 10 times. To multiply by 100, place two ciphers at the right of the multiplicand. To multiply by 1000, place three ciphers at the right of the multiplicand.

EXERCISE 26. — WRITTEN

1. Multiply 42 by 10, by 100, by 1000.
2. Multiply 24 by 10, by 100, by 1000.
3. Multiply 93 by 10, by 100, by 1000.
4. Multiply 930 by 10, by 100, by 1000, by 10,000.
5. Multiply 860 by 10, by 100, by 1000, by 10,000.

53. Find the product of 842×40.

$$\begin{array}{r} 842 \\ 40 \\ \hline 33680 \end{array}$$

The product is found by multiplying the multiplicand by 4 of the multiplier as if it stood alone and increasing the product ten times by placing a cipher at the right.

EXERCISE 27. — WRITTEN

1. Multiply 35 by 40, by 400, by 4000, by 400,000.
2. Multiply 350 by 40, by 400, by 4000, by 400,000.
3. Multiply 3500 by 3, by 30, by 300, by 3000, by 30,000.
4. Multiply 3500 by 6, by 60, by 600, by 6000, by 60,000.

54. Rule for multiplying when either multiplier or multiplicand ends in ciphers. Multiply the multiplicand by the multiplier without regard to the ciphers, and annex as many ciphers at the right of the product as are found at the right of the multiplier and multiplicand.

55. Multiply 4280 by 200.

$$\begin{array}{r} 4280 \\ 200 \\ \hline 856000 \end{array}$$

Multiply as if the problem read 428×2, securing the product 856. In thus omitting the ciphers the multiplicand is decreased tenfold and the multiplier one hundred fold, and the product is therefore decreased 10×100 or 1000 fold. The product then is 1000×856 or 856,000.

EXERCISE 28. — WRITTEN

Multiply:

1. 876,420 by 3600.
2. 960 by 4600.
3. 87,640 by 300.
4. 79,842 by 34,000.
5. 88,967 by 360.
6. 37,900 by 67,000.
7. 690,000 by 36,420.
8. 86,290 by 720.
9. 370 by 6700.
10. 296,380 by 3000.
11. 28,460 by 7200.
12. 67,981 by 37,100.

56. Find the product of 627×5864.

To find the product of 5864 multiplied by 627 we must think of 627 as 6 hundreds plus 2 tens plus 7 units, or $600 + 20 + 7$. Multiplying 5864 by each of these numbers separately as in *a*, *b*, and *c*, we obtain the three partial products 41,048, 117,280, and 3,518,400. The sum of these products is 3,676,728. This method of securing the partial products by separate multiplications is needlessly long. Since we know that in multiplying by a number having ciphers at the right

a.
```
 5864
  600
3518400
```

b.
```
5864
  20
117280
```

c.
```
 5864
    7
41048
```

d.
```
   5864
    627
  41048
 11728
35184
3676728
```

we may disregard the ciphers, we may here write the partial products directly under each other as in the second operation shown at *d*.

The products obtained by the separate multiplications are called **Partial Products.**

EXERCISE 29. — WRITTEN

Multiply:

1. 842 by 56.
2. 517 by 75.
3. 329 by 88.
4. 562 by 94.
5. 755 by 48.
6. 946 by 67.
7. 258 by 99.
8. 657 by 46.
9. 3063 by 538.
10. 3769 by 645.
11. 8035 by 928.
12. 2380 by 763.
13. 4938 by 529.
14. 9123 by 372.
15. 5073 by 418.
16. 6392 by 239.

57. Find the product of 6004 × 1281.

```
   1281
   6004
   5124
7686
7691124
```

Since the products corresponding to the zeros in the multiplier will be zeros, they need not be written in the partial products.

EXERCISE 30. — WRITTEN

Multiply:

1. 8375 by 206.
2. 8295 by 2006.
3. 2684 by 702.
4. 9367 by 9006.

5. 2473 by 906.
6. 2482 by 7002.
7. 2954 by 906.
8. 4375 by 603.
9. 7876 by 903.
10. 8345 by 9003.
11. 5878 by 809.
12. 7854 by 508.

58. **Rule for Multiplication.** — Write the multiplier under the multiplicand, units under units, tens under tens, etc. Multiply the multiplicand by each figure of the multiplier. Place the right-hand figure of each partial product under the figure of the multiplier used to obtain it. Add the partial products.

Since regarding either number as multiplier or multiplicand does not affect the product, in practice the smaller is used as the multiplier.

EXERCISE 31. — WRITTEN

Multiply:

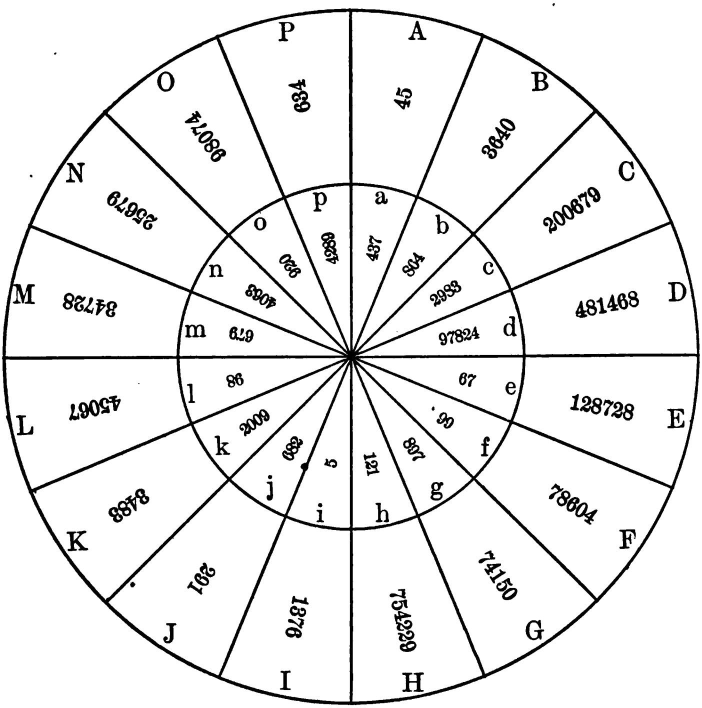
1. 7564 by 73.
2. 8715 by 86.
3. 4781 by 86.
4. 3692 by 90.
5. 5878 by 46.
6. 4689 by 76.
7. 5873 by 256.
8. 6381 by 634.
9. 9537 by 752.
10. 2175 by 396.
11. 7009 by 438.
12. 8254 by 576.
13. 7826 by 86.
14. 8957 by 79.
15. 6428 by 64.
16. 6753 by 97.
17. 8429 by 68.
18. 8867 by 29.
19. 8456 by 25.
20. 6397 by 86.
21. 9876 by 38.
22. 2785 by 89.
23. 5432 by 92.
24. 7654 by 47.
25. 8765 by 59.
26. 3528 by 463.
27. 3264 by 287.
28. 8163 by 799.
29. 2345 by 986.
30. 9543 by 576.
31. 7432 by 438.
32. 6473 by 823.
33. 9761 by 82.
34. 8472 by 34.
35. 9781 by 73.
36. 9999 by 99.
37. 8756 by 65.
38. 9522 by 76.
39. 7543 by 57.

The pupil may use the following problems sufficiently to gain skill in multiplying.

40–55. Multiply the number at small *a* in the diagram by each number in the larger circle.

56–295. Multiply each of the other numbers in the smaller circle by each number in the larger circle.

Note. The teacher may assign these problems by chance by making similar circles, pasting them upon pasteboard, and mounting the smaller one upon a pin so that it may revolve freely.



MULTIPLICATION OF UNITED STATES MONEY

59. Multiply \$95.35 by 25.

$$\begin{array}{r} \$95.35 \\ 25 \\ \hline 47675 \\ 19070 \\ \hline \$2383.75 \end{array}$$

Multiply as in integral numbers, and point off in the product as many places for cents as there are places for cents in the multiplicand.

EXERCISE 32. — WRITTEN

Find the product of :

1.	**2.**	**3.**	**4.**
$\begin{array}{r} \$65.83 \\ 9 \\ \hline \end{array}$	$\begin{array}{r} \$89.57 \\ 8 \\ \hline \end{array}$	$\begin{array}{r} \$48.75 \\ 28 \\ \hline \end{array}$	$\begin{array}{r} \$46.98 \\ 35 \\ \hline \end{array}$

5.	**6.**	**7.**	**8.**
$\begin{array}{r} \$640.25 \\ .89 \\ \hline \end{array}$	$\begin{array}{r} \$542.40 \\ 127 \\ \hline \end{array}$	$\begin{array}{r} \$864.19 \\ .95 \\ \hline \end{array}$	$\begin{array}{r} \$506.69 \\ 1588 \\ \hline \end{array}$

Multiply :

9. \$43.95 by 875.

10. \$640.50 by 346.

11. \$981.23 by 852.

12. \$300.20 by 945.

13. \$756.25 by 372.

14. \$675.30 by 981.

15. \$1250.25 by 806.

16. \$3540.30 by 905.

17. \$2859.65 by 79.

18. \$875.90 by 350.

EXERCISE 33. — WRITTEN

1. Since each State is represented in Congress by 2 senators, how many senators are there in Congress?

2. A mechanic earns $2.75 a day. What will be his wages for a week? For a month of 26 days?

3. A man earns $3.50 a day. What will be his wages for a week? For 26 days?

4. If a hunter's coat and shoes cost him $6.50 each and his gun costs 4 times as much as his coat, what is the cost of his outfit?

5. If it requires 23 yards of carpet for a floor, what will be the cost at $1.25 a yard?

6. What will be the cost of 18 cords of wood at $3.25 a cord?

7. What will be the cost of 3 barrels of sugar weighing 284 lbs. each at 6 cts. a pound?

8. How many feet of picture moulding will be required for a room 12 ft. long, 15 ft. wide?

9. What will moulding cost for the above room if two sizes are used, one at ceiling at 2 cts. a foot and a plate rail at 7 cts. a foot?

10. A storm moving eastward across the United States, travelling at the rate of 36 miles an hour, moves how far in 3 days?

11. If 1 cow drinks 73 lbs. of water daily, how many pounds of water will 16 cows drink? 28 cows? 69 cows?

12. If it costs $8.13 for labor and $7.39 for material for each acre, to spray a vineyard 6 times, what will it cost to spray 7 acres 6 times?

13. If 100 gallons of Bordeaux mixture are sprayed upon a melon field to prevent blight, and to make this mixture 6 lbs. of blue stone, at 7 cts. a pound, and 12 lbs. of lime, at 1 ct. a pound, are used, and the cost of labor is 33 cts., what will 1 spraying cost? What will 6 sprayings cost?

14. If unsprayed melons all die, and sprayed melons yield 150 baskets to the acre, at 76 cts. a basket, what is the gain by spraying 8 acres of melons?

15. If unsprayed grape-vines yield 1 lb. for each vine, and sprayed vines yield 4 lbs. each, what is the gain by spraying an acre which yields 376 lbs. when not sprayed?

16. If spraying potatoes 5 times increases the yield 63 bushels per acre, and spraying 3 times increases the yield 32 bushels, what is the increase from the last 2 sprayings? With potatoes at 65 cts. a bushel, what are the 2 extra sprayings worth to the farmer?

17. If the best selected potato seed yields an average of 11,100 lbs. per acre and poor seed yields 8034 lbs. per acre, how much more will 9 acres yield when planted with good seed than with poor seed?

18. If a dairy cow eats 40 lbs. of silage each day, how many pounds of silage will it take to feed 17 cows 180 days?

19. One field of wheat of 9 acres yields 22 bushels per acre, and another of the same size, due to better preparation, yields 31 bushels an acre. What is the difference in the value of the wheat produced on the two fields when wheat is worth 87 cts. per bushel?

20. One seven-acre field of cotton produces 215 lbs. of lint cotton and 430 lbs. of seed on each acre, while

another field of the same size produces 500 lbs. of lint and 1000 lbs. of seed per acre. What is the difference in the value of the crop from the two fields when cotton is worth 11 cts. a pound and seed 1 ct. a pound?

21. If an unclean sample of clover seed contains 990 weed seeds in each pound, how many weed seeds are there in each bushel weighing 60 lbs.?

22. A sample of unclean clover seed was found to contain 27,600 weed seeds in each pound. If 15 lbs. were sowed to an acre, how many weed seeds were planted on each acre?

23. A sample of clover seed offered for sale contained 338,300 weed seeds in each pound. How many weed seeds were there in each bushel of 60 lbs.?

24. What is the value of an acre of celery yielding 1500 dozen stalks at 26 cts. a dozen? If the annual growing expense is $259, what is the profit per acre?

25. There are 21,780 cubic feet in the upper 6 inches of an acre of soil. If this soil weighs 79 lbs. per cubic foot, how much will the upper 6 inches of soil on an acre weigh?

26. A man bought a car-load of cattle, 25 in number, each animal weighing 961 lb., at 4 cts. a pound. After each had gained 389 lbs. in weight, they were sold for 6 cts. a pound. What was his profit or loss if the feed consumed was worth $977, and the cost of labor to do the feeding $125?

27. A man bought 1728 acres of land at $67 an acre. He spent $3600 on improvements and then sold 79 acres at

$170 an acre, 160 acres at $165 an acre, 215 acres at $148 an acre, 450 acres at $132.18 an acre, and the rest at $45 an acre. How much did he gain or lose?

28. A common house-fly lays her eggs in broods of about 120 each. At this rate, how many flies may be expected from 29 overwintering flies during the first warm days of spring?

29. Mosquitoes lay eggs in masses of about 350 each. How many mosquitoes may be expected at the end of the hatching period from 9 such masses?

30. The white ant often lays as many as 80,000 eggs in a day. How many eggs may be expected from 30 laying ants at the end of 4 days' laying?

31. A man in each of his working months earns $67.50 and spends $28.37. What are his savings yearly, allowing one month of vacation during which he spends $56.97 more than usual?

32. A man bought 39 strips of carpet, each 17 yards long, at 86 cts. a yard. What did they cost?

33. A teamster hauling 4 loads of sand a day, of 27 cubic feet to the load, hauls how many cubic feet in 12 days?

34. Five boys purchase a camp outfit at the following prices: a 9-ft. tent for $5.80, two hammocks at 55 cts. each, five bathing suits at 55 cts. each, 1 clothes bag at 60 cts., 1 junior camp stove at $1.74, one boat at $19, 2 pairs of oars at $1 a pair, 4 fishing outfits at $1.89 each. What was the cost of the outfit? Two boys paid toward the outfit $12.22. What was left for the other three to pay?

DIVISION

60. If 3 gallons of milk yield 18 ounces of butter, how many ounces will 1 gallon yield?

To solve this problem we must think of 18 ounces as separated into 3 equal parts. Separating 18 ounces into 3 equal parts will give 6 ounces in each part.

61. The process of separating a number into equal parts is called **Division.**

62. The number to be divided, or the number to be separated into equal parts, is called the **Dividend.**

63. The number that indicates into how many equal parts the dividend is to be separated, or the number by which the dividend is to be divided, is called the **Divisor.**

64. The result obtained by Division is called the **Quotient.**

To find the number of ounces of butter contained in 1 gallon of milk we divided 18 ounces by 3 (not by 3 gallons) which gave 6 ounces. Three, the divisor in this problem, is an abstract number, and the term 3 gallons serves only to indicate the number of groups into which 18 ounces is to be separated.

65. When the dividend is concrete and the divisor is abstract, the quotient is like the dividend, *e.g.*, 18 oz. $\div$ 3 $=$ 6 oz.

66. When the dividend and divisor are concrete, they must be alike and the quotient will be abstract, *e.g.*, 18 oz. ÷ 6 oz. = 3.

67. Division is indicated by the sign, ÷, or by writing the dividend above the divisor with a line between, thus $18 \div 3 = 6$, or $\frac{18}{3} = 6$, is read, 18 divided by 3 equals 6.

68. When the division is not exact, the part of the dividend remaining is called the **Remainder**, *e.g.*, $15 \div 2 =$ 7, with 1 as a remainder.

69. When two or more numbers are multiplied together to produce a product, *e.g.*, $3 \times 6 = 18$, the numbers so multiplied are called the **Factors** of the product.

70. In the problem $18 \div 3$, observe that we have the product 18 and one factor 3, to find the other factor. We may therefore think of division as the process of finding one factor when the product and the other factor are given.

EXERCISE 34.—ORAL

Find the quotients of the following and prove the division correct by multiplying the factors together:

1.	$4 \div 2 =$	because	$2 \times$	$= 4.$
2.	$6 \div 3 =$	because	$3 \times$	$= 6.$
3.	$8 \div 4 =$	because	$4 \times$	$= 8.$
4.	$18 \div 9 =$	because	$9 \times$	$= 18.$
5.	$24 \div 6 =$	because	$6 \times$	$= 24.$
6.	$42 \div 7 =$	because	$7 \times$	$= 42.$
7.	$40 \div 8 =$	because	$8 \times$	$= 40.$
8.	$72 \div 6 =$	because	$6 \times$	$= 72.$

9. $72 \div 9 =$ because $9 \times \quad = 72$.

10. $63 \div 7 =$ because $7 \times \quad = 63$.

EXERCISE 35.—ORAL

1. The year contains 4 seasons. How many months in each season?

2. Alfred the Great divided the day into 3 equal periods, for sleep, work, and recreation. How many hours were there in each period?

3. If $1 is changed to ten-cent pieces, how many are there?

4. If $1 is changed to five-cent pieces, how many are there?

5. If $1 is changed to twenty-five-cent pieces, how many are there?

6. If $1 is changed to twenty-five-cent, ten-cent, and five-cent pieces, in how many ways can the change be made?

7. With lettuce plants set 11 in. apart, how many will be required for 1 row in a cold frame 88 in. long?

8. The rows are 10 in. apart. How many rows are there in a cold frame 60 in. wide?

9. In a fruit garden 165 ft. long, how many peach trees will be required to set a row, placing them 15 ft. apart?

10. How many rows can be set in a garden 90 ft. wide?

11. An English shilling equals nearly 25 cts. in our money? How many shillings in $1.50?

12. A French franc equals about 20 cts. in our money. How many francs in $3.00?

13. A German mark equals about 24 cts. in our money. How many marks in $2.88?

14. An Italian lira equals about 20 cts. in our money. How many lire in $5.60?

15. A Dutch florin equals about 40 cts. in our money. How many florins in $3.60?

16. An Austrian florin equals about 36 cts. in our money. How many florins in $1.80?

17. At $72 a dozen for suits for sixteen-year-old boys, what is the cost of each suit?

18. There are 7 days in 1 week; how many weeks in 28 days? in 42 days? in 98 days?

19. If a man earns $8 while a boy earns $3, how much will the boy earn while the man earns $48?

20. If an adult man eats 360 grams of carbohydrates, 120 grams of protein, and 60 grams of fats each day, how much does he average per meal?

21. If a laboring man eats 150 grams of protein, 99 grams of fats, and 516 grams of carbohydrates each day, what is the average per meal?

22. If a man can do as much work as 3 boys, and it requires 48 boys 3 days to build a fence, how long will it require 8 men to build it?

23. If a man can hoe twice as much as a boy, and 4 boys and 3 men hoe a field of 5 acres in a day, what amount does each hoe?

SHORT DIVISION

71. When the divisor is so small that the work can be performed mentally, the process is called **Short Division.**

72. Divide 9672 by 4.

$$4\overline{)9672}$$
$$2418$$

The divisor is written at the left of the dividend with a curved line between them and a line underneath the dividend. To divide 9672 by 4, begin at the left and find how many times the divisor, 4, is contained in the first figure of the dividend. 4 is contained in 9 two times, with a remainder 1. Reduce the 1 to the next lower order, making 10, which with 6 makes 16; 4 is contained in 16 four times. 4 is contained in 7 one time, with a remainder 3. This remainder reduced to the next lower order makes 30, which with 2, the next figure of the dividend, makes 32; 4 is contained in 32 eight times. The quotient, therefore, is 2418.

73. Divide 3651 by 7.

$$7\overline{)3651}$$
521 with 4 remainder, commonly written $\frac{4}{7}$.

7 is not contained in the first figure of the dividend, 3, so the 3 must be reduced to the next lower order, making 30, which with 6 makes 36. 7 is contained in 36 five times, with 1 remainder. Reduce 1 to next lower order, making 10, which with 5 makes 15. 7 is contained in 15 two times and 1 remainder. 1 is reduced to next lower order, making 10, which with 1 makes 11. 7 is contained in 11 one time, with 4 as remainder. This final remainder is indicated with the quotient. The quotient, therefore, is 521, with 4 remainder.

EXERCISE 36. — WRITTEN

Find the quotient of:

1. $376 \div 2$.
2. $595 \div 5$.
3. $459 \div 9$.
4. $376 \div 5$.
5. $714 \div 4$.
6. $628 \div 7$.
7. $984 \div 8$.
8. $594 \div 7$.
9. $4395 \div 6$.
10. $9656 \div 8$.
11. $7985 \div 9$.
12. $7983 \div 8$.
13. $8457 \div 6$.
14. $2708 \div 8$.
15. $8736 \div 7$.
16. $7036 \div 6$.
17. $8232 \div 4$.
18. $8361 \div 9$.
19. $5643 \div 8$.
20. $3716 \div 7$.
21. $5472 \div 6$.
22. $7483 \div 5$.
23. $8721 \div 7$.
24. $9212 \div 9$.
25. $73{,}236 \div 11$.
26. $24{,}631 \div 12$.
27. $75{,}477 \div 12$.
28. $36{,}286 \div 21$.
29. $56{,}216 \div 12$.
30. $83{,}542 \div 15$.
31. $64{,}902 \div 11$.
32. $85{,}563 \div 14$.
33. $37{,}642 \div 12$.
34. $48{,}527 \div 15$.
35. $87{,}585 \div 9$.
36. $96{,}464 \div 22$.
37. $83{,}691 \div 12$.
38. $77{,}585 \div 11$.
39. $23{,}075 \div 14$.
40. $89{,}576 \div 11$.
41. $98{,}254 \div 15$.
42. $61{,}082 \div 21$.

74. How many tens in 20? How many hundreds in 200? How many thousands in 2000?

To divide by 10, 100, 1000, etc., set off as many figures at the right of the dividend as there are ciphers in the divisor. The figures thus set off are the remainder. The other figures are the quotient, *e.g.*, $45 \div 10 = 4$, with 5 as remainder. $468 \div 100 = 4$, with 68 as a remainder.

EXERCISE 37. — ORAL

1. $57{,}683 \div 100$.
2. $76{,}493 \div 100$.
3. $38{,}425 \div 100$.
4. $54{,}580 \div 100$.

5. 42,676 ÷ 1000.	8. 57,826 ÷ 10,000.
6. 26,257 ÷ 1000.	9. 32,814 ÷ 10,000.
7. 14,637 ÷ 1000.	10. 82,740 ÷ 10,000.

75. Divide 4560 by 200.

$$200\overline{)4560}$$
$$22\tfrac{160}{200}$$

Cut off ciphers at the right of the 200, also two figures at the right of the dividend. Dividing 45 by 2 gives 22, with 1 remainder. The 1, which represents 100, added to the 6, which represents 60, gives 160 remainder.

When the divisor ends in one or more ciphers, cut these off, and also cut off an equal number of figures from the right of the dividend. Then divide by the figures remaining. Place the figures cut off from the dividend at the right of the remainder, if there is a remainder, to form the true remainder.

EXERCISE 38.—WRITTEN

Find the quotient of:

1. 376 ÷ 20.	12. 7534 ÷ 300.
2. 285 ÷ 50.	13. 35,456 ÷ 500.
3. 653 ÷ 60.	14. 96,464 ÷ 800.
4. 981 ÷ 40.	15. 58,775 ÷ 700.
5. 9212 ÷ 80.	16. 28,976 ÷ 600.
6. 9064 ÷ 70.	17. 92,123 ÷ 400.
7. 887 ÷ 60.	18. 82,601 ÷ 700.
8. 954 ÷ 50.	19. 42,563 ÷ 800.
9. 3730 ÷ 90.	20. 30,600 ÷ 300.
10. 3645 ÷ 200.	21. 67,332 ÷ 200.
11. 4328 ÷ 300.	22. 85,563 ÷ 400.

LONG DIVISION

76. Long division is the same as short division, with the exception that all the processes are written in full. The quotient is written over the dividend, the first figure of the quotient being written over the right-hand figure of the dividend used in obtaining it.

77. Divide 32,962 by 49.

It will be found helpful in the beginning of the study of long division to form a table of products of the divisor with numbers from 1 to 9. The problem is arranged as in short division, with the exception that the quotient is written either above (or at the right of) the dividend. Since 49 is not contained in 32, we must use the first three figures of the dividend, 329, for the first **partial dividend**. By consulting the table of products, we find that 294 is the largest of the products that does not exceed the partial dividend, 329.

TABLE OF PRODUCTS

$1 \times 49 = 49$
$2 \times 49 = 98$
$3 \times 49 = 147$
$4 \times 49 = 196$
$5 \times 49 = 245$
$6 \times 49 = 294$
$7 \times 49 = 343$
$8 \times 49 = 392$
$9 \times 49 = 441$

$$\begin{array}{r@{}l} 672 & \\ 49)\overline{32962} & \\ \underline{294} & \\ 356 & \\ \underline{343} & \\ 132 & \\ \underline{98} & \\ 34 & \text{ remainder.} \end{array}$$

294 is the product of 6×49; hence, 49 is contained in 329 six times. 6 is written over the 9 of the dividend. The product of the 6×49, 294, is subtracted from 329, which leaves as a remainder 35. The next figure of the dividend, 6, is annexed to form the second partial dividend. 343 is the largest of the products that does not exceed this partial dividend, 356. 343 is the

product of 7×49; hence, 49 is contained in 356 seven times. 7 is written over the 6 of the dividend and 343, the product of 7×49, is subtracted from 356, which leaves 13 remainder. The next figure of the quotient, 2, is annexed to form the third partial dividend, 132. 98 is the largest of the products that does not exceed this partial dividend, 132. 98 is the product of 2×49; hence, 49 is contained in 132 two times. 2 is written over 2 of the dividend and 98 is subtracted from 132, leaving 34 the final remainder.

78. Divide 1,270,563 by 396.

$$\begin{array}{r@{}l} & 3208\tfrac{195}{396} \\ 396) & \overline{1270563} \\ & \underline{1188} \\ & 825 \\ & \underline{792} \\ & 3363 \\ & \underline{3168} \\ & 195 \end{array}$$

After some practice the quotient figures can be estimated without making the table of products. The first partial dividend is 1270. 396 is contained in 1270 three times. $3 \times 396 = 1188$. 1188 subtracted from 1270 leaves 82 remainder. Annexing 5 gives the second partial dividend, 825. 396 is contained in 825 two times. $2 \times 396 = 792$. 792 subtracted from 825 leaves 33 remainder. Annexing 6 gives the third partial dividend, 336. 396 is not contained in 336, so a cipher is written over the 6 of the dividend and the next figure of the dividend, 3, is annexed to 336 to form the next partial dividend, 3363. 396 is contained in 3363 eight times. $8 \times 396 = 3168$. 3168 subtracted from 3363 gives 195, the final remainder.

79. Rule for Long Division.

I. Write the divisor at the left of the dividend with a curved line between them. For the first partial dividend take the fewest number of figures at the left of the dividend that will contain the divisor, and write the partial quotient over the right-hand figure of the partial dividend.

II. Multiply the divisor, by this quotient, and write the product under the partial dividend used.

III. Subtract this product, and to the remainder annex the next figure of the dividend for the second partial dividend.

IV. Divide as before, and continue the process until all the figures of the dividend have been used to make partial dividends.

V. If there be a remainder, write it with the quotient.

Proof. Find the product of the divisor and quotient, and to this product add the remainder, if any. If the work is correct, the result will equal the dividend.

EXERCISE 39. — WRITTEN

Find the quotient of:

1. 5280 ÷ 12.
2. 1728 ÷ 12.
3. 1607 ÷ 19.
4. 5347 ÷ 21.
5. 3987 ÷ 94.
6. 6784 ÷ 73.
7. 6548 ÷ 89.
8. 8789 ÷ 65.
9. 5498 ÷ 98.
10. 3850 ÷ 63.
11. 3987 ÷ 91.
12. 4783 ÷ 43.
13. 3402 ÷ 81.
14. 6281 ÷ 71.
15. 3485 ÷ 873.
16. 6842 ÷ 78.
17. 89,314 ÷ 86.
18. 54,963 ÷ 863.
19. 33,765 ÷ 542.
20. 84,568 ÷ 827.
21. 74,938 ÷ 357.
22. 861,618 ÷ 843.
23. 98,125 ÷ 563.
24. 84,629 ÷ 189.
25. 54,825 ÷ 254.
26. 46,376 ÷ 308.
27. 879,384 ÷ 508.
28. 343,861 ÷ 948.
29. 324,924 ÷ 357.
30. 672,425 ÷ 135.
31. 861,254 ÷ 927.
32. 938,764 ÷ 879.

	a	*b*	*c*
1	3762894	42896	329
2	3862847	76298	269
3	9683921	42546	873
4	1897892	79832	784
5	3984291	62891	672
6	8996823	79684	981
7	8672984	62341	679
8	6293478	98641	837
9	7986277	82439	568
10	1291382	87897	674

The pupil should practise dividing sufficiently to become skilful.

33–42. Divide the first number of column *b* by each number of column *c*.

43–132. Divide each other number in column *b* by each number in column *c*.

133–142. Divide the first number in column *a* by each number in column *b*.

143–232. Divide each other number in column *a* by each number in column *b*.

DIVISION OF UNITED STATES MONEY

80. Divide \$741.32 by 86.

```
      $8.62
86)$741.32
     688
      533
      516
       172
       172
```

Divide as in integral numbers, writing the first figure of the quotient over the right-hand figure of the first partial dividend. **Place the decimal point in the quotient directly over the decimal point in the dividend.**

81. Divide \$46.75 by \$.25.

```
    187
25)4675
   25
   217
   200
    175
    175
```

Change the dividend and divisor to cents which gives 4675 cents to be divided by 25 cents. The answer is 187.

EXERCISE 40. — WRITTEN

Find the quotient of:

1. \$17.28 ÷ 12.
2. \$17.28 ÷ \$12.
3. 17.28 ÷ .12.
4. 856.90 ÷ 41.
5. 856.90 ÷ \$41.
6. \$52.56 ÷ 16.
7. \$52.54 ÷ \$16.
8. \$52.54 ÷ .16.
9. \$438.90 ÷ 21.
10. \$438.90 ÷ \$21.

EXERCISE 41. — WRITTEN

1. If 8 bushels of rye weigh 448 lbs., what is the weight of 1 bushel?

2. If 19 bushels of oats weigh 608 lbs., what is the weight of 1 bushel of oats?

3. If 27 bushels of wheat weigh 1620 lbs., what is the weight of a bushel of wheat?

4. If 32 bushels of corn weigh 1792 lbs., what is the weight of a bushel of corn?

5. If 37 bushels of peas weigh 2220 lbs., what is the weight of 1 bushel of peas?

6. How many boys' sweaters at 95 cts. can be bought for $6.65?

7. A double plow harness costing $11.48 and a double carriage harness costing $45.92, how many plow harnesses can be had at the cost of 1 carriage harness?

8. If a beef animal weighs 960 lbs. at the beginning of the feeding period, and after being fed 162 days weighs 1284 lbs., how much did it gain a day?

9. If 40 lbs. of silage is the ration for a dairy cow, how many acres of corn will it take to produce silage for 15 cows for 150 days, 1 acre of corn producing 18,000 lbs. of silage?

10. A base-ball outfit for the Asheboro High School Nine consists of the following articles: an American Association ball 70 cts., 9 Junior League bats at 25 cts. each, 1 catcher's mit $1.00, 3 fielder's gloves at 55 cts., 1 first-baseman's mit 90 cts., 4 infielder's gloves at 30 cts., 1 amateur mask 50 cts., 9 pairs shoe plates

10 cts. per pair, catcher's breast protector $1.10, 9 uniforms at $1.25 each, 9 sweaters at $1.25 each. What part of the entire cost should each member pay?

11. The foot-ball eleven of Shelbyville Academy is equipped with the following articles: boy's Rugby foot-ball with bladder $1.50, inflater 15 cts., 11 jackets at 60 cts. each, 11 pairs of pants at $1.00 each, 9 pairs shin guards at 45 cts. per pair, 6 pairs shoulder pads at 30 cts. per pair, 1 head harness at 75 cts. What part of the cost of the outfit does each member pay?

12. The Asheboro High School Girls' Tennis Club ordered a tennis outfit as follows: 2 hardwood poles at 75 cts. a pair, guy ropes and pins 23 cts. per set, court marker 95 cts., net $2.00, 2 back-stop nets $2.15 each. What will it cost to equip three courts? What part will each member pay if the club is composed of 40 members?

13. The Croquet Club has 2 croquet sets at $2.50 a set. There are 16 members. What part of cost does each pay?

14. If a man buys 1 ton of commercial fertilizer for $24 and puts it on 4 acres, and another ton for $20 and puts it on 5 acres, how many additional pounds of cotton to the acre must he produce on the first field at 10 cts. a pound to pay for the greater cost of the fertilizer used thereon?

15. The following results for a period of 5 years' spraying Irish potatoes to prevent disease are recorded in New York: gain per acre due to spraying every 2 weeks, 123, 118, 233, 119, 63 bushels; gain per acre due to 3 sprayings, 98, 88, 191, 107, 32 bushels. What was the

average gain for the 5 years with 3 sprayings? What was the average gain from spraying every 2 weeks? If potatoes average 57 cts. a bushel and spraying cost on an average 77 cts. an acre each time, what was the average gain from spraying 3 times?

16. If 5 gallons of spraying mixture be used to each tree in an apple orchard of 1000 trees and Paris green at 20 cts. a pound be used, 1 lb. to 150 gals. of water, what would be the cost of the Paris green for 2 sprayings? What would it cost per tree?

17. A pig weighing 50 lbs. cost $4. After eating 8 bus. of corn at 50 cts. a bushel and 400 lbs. of wheat middlings at $1 a hundred pounds, it weighs 250 lbs. At how much a pound must it be sold to make a net profit of $3?

18. What is the average of 79, 83, 160, 74, and 62?

19. At three places in the Florida peninsula the number of partly cloudy days in the year was 233, 145, 113, the number of cloudy days was 59, 74, 81. What was the average number of cloudy, partly cloudy, and clear days as shown by these observations?

20. A man bought 782 acres of land for $98,762 and sold it at $18 an acre. What was the average price paid? What was the average gain or loss per acre?

21. The deaths from consumption in the United States in 1900 were 111,059. What was the average number of deaths for each day in the year (365 days)?

22. The deaths from typhoid fever in the United States for 1900 were 35,379. What was the average number daily?

CANCELLATION

82. How many times is 3×6 contained in 12×6? How many times is 3×10 contained in 6×10? How many times is 6×7 contained in 12×7?

83. Divide 24×12 by 6×12.

$24 \times 12 = 288 \qquad 6 \times 12 = 72 \qquad 288 \div 72 = 4.$

What factor is common to both dividend and divisor? If the factor 12 is struck out, or **cancelled**, from both dividend and divisor, does it affect the quotient?

$$\frac{24 \times \cancel{12}}{6 \times \cancel{12}} = \frac{24}{6}, \text{ or } 24 \div 6 = 4.$$

Divide $5 \times 27 \times 4$ by 18×2.

$$\frac{5 \times \overset{3}{\cancel{27}} \times \overset{\cancel{2}}{\cancel{4}}}{\underset{\cancel{2}}{\cancel{18}} \times \cancel{2}} = 15.$$

Cancelling the common factor 2 from the 4 of the dividend and the 2 of the divisor gives 2 in the dividend. Cancelling the common factor 9 from 18 gives 2; from 27 gives 3. Cancel 2 from both divisor and dividend. Multiplying the remaining factors of the dividend gives the quotient, 15.

84. Cancellation is the process of shortening work in division by removing or cancelling equal or common factors from the dividend and divisor.

EXERCISE 42. — WRITTEN

Solve by cancellation:

1. Divide $7 \times 6 \times 16$ by $6 \times 8 \times 7$.

2. Divide $11 \times 27 \times 30$ by $9 \times 15 \times 3$.

3. Divide $15 \times 48 \times 70 \times 11 \times 40$ by $30 \times 16 \times 7 \times 22 \times 50$.

4. Divide $84 \times 13 \times 5$ by $91 \times 4 \times 15$.

5. Divide $27 \times 12 \times 35 \times 14$ by $9 \times 3 \times 5$.

6. Divide $48 \times 35 \times 42 \times 54$ by $12 \times 7 \times 6 \times 9$.

7. Divide $63 \times 36 \times 48 \times 96 \times 27$ by $81 \times 9 \times 12 \times 48$.

8. Divide $420 \times 68 \times 88 \times 22$ by $210 \times 11 \times 44$.

9. Divide $42 \times 35 \times 56 \times 4 \times 12$ by $28 \times 49 \times 14 \times 10$.

10. Divide $17 \times 9 \times 12 \times 11 \times 28$ by $34 \times 6 \times 72 \times 6 \times 22$.

11. Divide $24 \times 15 \times 8 \times 4 \times 7$ by $14 \times 8 \times 6 \times 4$.

12. Divide $20 \times 16 \times 5 \times 3 \times 6$ by $5 \times 8 \times 3 \times 10 \times 6$.

13. 18 cows, each eating 4 lbs. of cotton-seed meal a day, can be fed how long on 360 lbs. of meal?

14. 72 quarts of berries at 9 cts. a quart equal in value how many pounds of sugar at 6 cts. a pound?

15. How long will it take a horse travelling 8 miles an hour to go as far as an express train goes in 3 hours at 32 miles an hour?

16. If 42 bushels of wheat make 9 barrels of flour, how many bushels will it take to make 27 barrels?

17. How many bushels of corn worth 49 cts. a bushel must be given in exchange for 63 bushels of oats worth 35 cts. a bushel?

18. How many bushels of oats worth 28 cts. a bushel must be grown on an acre to equal in value a crop of 56 bushels of corn worth 42 cts. a bushel?

19. A lumber mill cuts 60,000 ft. of lumber in 6 hours. How many feet will it cut in 3 days of 8 hours each?

EXERCISE 43.—WRITTEN

Review Problems

1. The population of Chicago in 1840 was 4470, in 1870 it was 300,000, in 1900 it was 1,698,675. What was the yearly increase in population from 1840 to 1870? What was the yearly increase from 1870 to 1900? What was the daily increase?

2. The value of the hay crop raised in the United States for five years was as follows:

1902	$542,036,364.
1903	$556,376,880.
1904	$529,107,625.
1905	$515,959,784.
1906	$592,539,671.

What was the total value for five years? What was the average value? How much below the average was the value of the smallest crop?

3. The value of the corn exported from the United States for five years was as follows:

1902	$16,185,673.
1903	$40,540,673.
1904	$30,071,334.
1905	$47,446,921.
1906	$62,061,856.

What was its total value? What was its average value? What was the difference between the largest and the smallest amount exported?

4. A farmer has a small herd of 5 dairy cows which produce as follows:

No. 1 = 396 lbs. butter a year, at 26 cts. a pound, cost of feed $59.00
No. 2 = 323 lbs. butter a year, at 26 cts. a pound, cost of feed $57.50
No. 3 = 257 lbs. butter a year, at 26 cts. a pound, cost of feed $55.67
No. 4 = 176 lbs. butter a year, at 26 cts. a pound, cost of feed $52.38
No. 5 = 147 lbs. butter a year, at 26 cts. a pound, cost of feed $49.84

What is the yearly profit on the herd? What is the profit or loss on each cow?

If he sells Nos. 4 and 5 and buys instead 2 other cows which produce as follows:

No. 6 = 298 lbs. butter a year at a cost for feed of $57.23
No. 7 = 276 lbs. butter a year at a cost for feed of $54.50

what will be his yearly profit on the herd? on each cow?

5. The value of the cotton exported from the United States for 5 years was as follows:

1902 . . . . $291,598,350.
1903 . . . . $317,065,271.
1904 . . . . $372,049,264.
1905 . . . . $381,398,939.
1906 . . . . $401,005,921.

What was the total value of the exported cotton? What was the average yearly value?

6. A farmer delivered to a creamery during May 3674 lbs. of milk, during June 4876 lbs., July 3929 lbs., August 3167 lbs., September 3067 lbs., October 2913 lbs. What was the total number of pounds during the half year?

7. During November a farmer delivered to the creamery 2974 lbs. of milk, during December 2984 lbs., January 2798 lbs., February 2890 lbs., March 3043 lbs., April 3364 lbs. What was the total number of pounds delivered during the latter half of the year? How much less was this than in the warmer half of the year?

8. What number multiplied by 256 with 23 added to the product will give 5399?

9. Light travels 186,680 miles a second. How far will it travel in 29 seconds?

10. Sound travels 1130 feet in a second. How far will it travel in 29 seconds?

11. It is, in round numbers, 25,000 miles around the earth. How many times will a light wave go round the earth in a second?

12. What is the number nearest to 3980 which is divisible by 234 without a remainder?

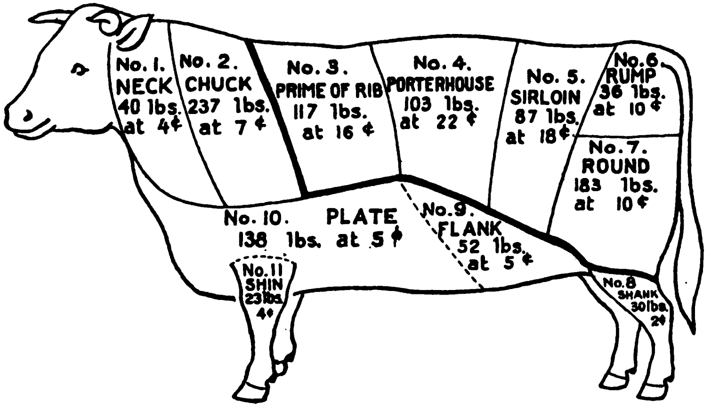
13. In the United States in 1899, $49,099,936 was spent for fertilizers. This being used on 4,970,129 farms was an average of how many dollars' worth on each farm?

14. In 1880 the expenditure of the United States for fertilizers was $28,500,000, in 1890 it was $38,500,000, in 1900 it was $54,750,000. How much more was spent for fertilizers in 1900 than in 1880? in 1900 than in 1890? in 1890 than in 1880? How much less in 1900 than in 1880 and 1890 together?

15. The shrinkage in weight of corn due to drying between December and May is about 9 lbs. for every hundred pounds. What would be the loss in weight of 900 bushels (1 bu. = 56 lbs.)? The price of corn advances on an average 4 cts. a bushel between December and May. Will this advance in price compensate for the loss due to shrinkage with corn in December at 57 cts. per bushel?

16. The expenses of raising an acre of white pine from the seed may be stated as follows:

Cost of seedlings, $2.00. Cost of land, $6.00. Transplanting to nursery, $1.21. Transplanting to field, $5.45. Taxes, first decade, $1.69. Taxes, second decade, $3.04. Taxes, third decade, $4.39. Taxes, fourth decade, $5.74. What is the total cost?



CUTS OF BEEF

The above illustration shows butchers' cuts, their relative weights, and Western retail prices; live weight of animal 1550 lbs., dressed weight of carcass 1046 lbs.

Cheap Cuts	Valuable Cuts
No. 1. Neck, 40 lbs. @ 4 cts.	No. 3. Prime of Rib, 117 lbs. @ 16 cts.
No. 2. Chuck, 237 lbs. @ 7 cts.	No. 4. Porterhouse Steak, 103 lbs. @ 22 cts.
No. 8. Shank, 30 lbs. @ 2 cts.	No. 5. Sirloin Steak, 87 lbs. @ 18 cts.
No. 9. Flank, 52 lbs. @ 5 cts.	No. 6. Rump, 36 lbs. @ 10 cts.
No. 10. Plate, 138 lbs. @ 5 cts.	No. 7. Round Steak, 183 lbs. @ 10 cts.
No. 11. Shin, 23 lbs. @ 4 cts.	

17. The difference between the live weight and the dressed weight is the waste in slaughtering. How much was it in the animal illustrated?

18. The parts of the carcass numbered 1, 2, 8, 9, 10, and 11 are in the forward and lower parts of the animal, and are less valuable. How many pounds are there in all these cheaper parts? What is their total value?

19. The parts numbered 3, 4, 5, 6, and 7 are in the hind quarters and upper portion of the body, and are more valuable. How many pounds are there in all these parts? What is their total value?

20. What is the difference in the total weights of the cheaper and the more expensive cuts? What is the difference in their values?

21. What is the average value per pound of the entire carcass? What is the average value per pound of the cheaper cuts? What of the more expensive cuts?

22. One animal weighing 1550 lbs. produces a dressed carcass of 1046 lbs. that sells for 9 cts. a pound; an inferior animal of the same live weight produces a carcass of 990 lbs. that sells for 8 cts. a pound. How much greater is the value of the better animal?

POULTRY

23. If 1 gallon of water glass mixed with 15 gallons of water makes a solution which will preserve 50 dozen eggs, what is the gain in putting up 25 dozen fresh eggs in summer when they are worth 15 cts. a dozen and keeping them until winter when they are worth 25 cts. a dozen?

24. If a lot of 8 dozen eggs that weighs 9 lbs. sells for 27 cts. a dozen, how much do they bring a pound? What will be the gain in selling another lot of 8 dozen eggs that weighs 14 lbs. for the same price per pound instead of the usual way of selling them at the same price per dozen?

25. A flock of hens averages 12 dozen eggs for each hen yearly. If they each consume $1.45 worth of feed, what is left to pay for their care, ~~losses from death~~, and profit, if the eggs bring an average price of 22 cts. a dozen?

26. If to raise 73 chicks to 8 weeks of age costs: for eggs set $2.50, heat for incubators and brooders $1.00, feed $3.87, what is the average cost per chick?

27. If a flock of hens fed dry mash and grain produces 216 dozen eggs at a cost of 11 cts. a dozen, and a second flock of the same number fed wet mash and grain produces 163 dozen eggs at a cost of 10 cts. a dozen, how much greater is the profit from the first flock if eggs sell for 22 cts. a dozen?

28. If the total weight of the chicks in problem 26 be 109 lbs., what is the average cost per pound?

29. If they are sold at 23 cts. each, what remains to pay for the labor and profit?

30. By inquiry find the local prices and costs in your neighborhood, and substitute them in problems 25 and 26.

PREVENTION OF PLANT DISEASES

TOTAL YIELD OF MARKETABLE POTATOES FROM TWO ROWS SPRAYED

TOTAL YIELD OF MARKETABLE POTATOES FROM TWO ROWS NOT SPRAYED

31. In treating seed oats to prevent oat smut, 1 ounce of formalin is used to every 3 gallons of water, and 1 gallon of this mixture suffices for 1 bushel of oats. How many ounces of formalin will be needed to treat 24 bushels of oats?

32. Using 3 bushels of seed oats to the acre, what will be the cost of sufficient formalin to treat seed for 80 acres at 35 cts. for each 16 ounces?

33. The Bordeaux mixture consists of blue stone 5 lbs., lime 5 lbs., and water 50 gallons. With blue stone costing 7 cts. a pound and lime at 1 ct. a pound, what will the materials for 150 gallons of Bordeaux mixture cost?

34. It requires about 150 gallons of Bordeaux mixture to spray an acre of Irish potatoes once. What will the materials for 3 sprayings cost?

35. Spraying apple trees twice with Bordeaux-Paris-green mixture to prevent worminess costs 13 cts. for each tree. If this increases the value of the yield $1.37 for each tree, what will be the gain by spraying an orchard of 87 trees?

36. The cost of labor and materials for spraying an acre of grapes to prevent the black rot being as follows, what is the cost of each spraying and the total cost of labor and materials for the six sprayings?

	Cost of Material	Cost of Labor	Total Cost
1st spraying	$0.45	$1.13	——
2d spraying	0.68	1.13	——
3d spraying	0.68	1.10	——
4th spraying	1.36	1.47	——
5th spraying	2.06	1.65	——
6th spraying	2.06	1.65	——
Total	——	——	——

37. The average cost of spraying Irish potatoes to prevent blight being $5.18 an acre, and the average increase in value being $19.07 an acre, what is the average profit from spraying?

38. Six unsprayed apple trees yielded 188 sound apples and 4244 rotten apples. Six similar trees sprayed yielded 8674 sound apples and 989 rotten ones. What was the gain for each tree in sound apples from spraying? What was the decrease in rotten apples for each tree?

39. What would it cost to spray the potatoes and apples and to treat all the oat seed planted within a mile of your school?

40. What would the profit be if it equalled per acre the increase indicated in the above problems?

A Bountiful Harvest

FARM CROPS

41. The average yield of wheat for the United States for each acre in 1906 was about 15 bus., the price was 67 cts. a bushel. What was the value of the yield per acre?

42. The average yield in some States is about 10 bus., in others 32 bus. How much greater value per acre is produced in the latter than in the former?

43. If it costs $2.16 for fertilizer, 96 cts. for seed, 37 cts. for housing, $1.20 for threshing, 76 cts. for marketing, and $2.81 for rent per acre in the United States, what is the average left to pay for labor and profit?

44. What is left for labor and profit in the low-yielding States?

45. What is left for labor and profit in the higher-yielding States?

46. If one farm yields 40 bus. an acre and another farm 16 bus. an acre, each at a cost of $9.67, how much greater

is the value of the yield on the former farm, supposing the farms to consist of 79 acres each? How much greater is the profit?

47. If a 3000-lb. crop of cow-pea hay per acre is grown on these fields, the stubble and roots will add 28 lbs. of nitrogen, worth 19 cts. a pound. What is the value of the nitrogen added?

48. Find by inquiry the average yield of each of the above crops in your locality, and substitute your local value in the problems, and solve.

SHIPPING

Goods are shipped by express or freight, the former commonly being used for lighter articles or when speed is necessary. The freight rate varies with the articles shipped, there being some twelve or more classes. In the following table the class is indicated in parenthesis after the name of the article. The smallest charge made is usually equal to that on 100 lbs. of the class of goods shipped.

Empty barrels (6)
Trunks of baggage (1)
Trunks limited to $5 a hundred (D 1)
Clothing (1)
New furniture, set up (1)
New furniture, not set up (2)
Furniture, old, value limited to $5 per 100 (4)
Furniture, old, car-load lots (6)
Vegetables: potatoes, onions, cabbage, etc. (6)
Bicycles, set up (1)
Bicycles, not set up (2)
Vegetables, canned, less than car-load (2)
Vegetables, canned, in car-load lots (4)

Grapes (1)	Flour (6)
Apples and pears in baskets (2)	Baled hay (D)
	Plows, set up (2)
Apples and pears in sacks or barrels (6)	Plows, not set up (4)
	Power cutter, set up (1)
Grain in bulk (D)	Power cutter, not set up (3)

The freight rate between two cities per 100 lbs. being: 1st class $1.03, 2d 92 cts., 3d 79 cts., 4th 65 cts., 5th 54 cts., 6th 43 cts., A 33 cts., B 39 cts., D 33 cts., E 54 cts., H 66 cts.

Solve the following problems:

49. What will be the freight on a shipment of bicycles, weight 200 lbs., set up? Not set up? In a shipment of bicycles weighing 500 lbs., what is the saving in freight if they be not set up?

50. How much cheaper is it to ship 1500 lbs. of new furniture not set up than to ship it set up?

51. How much cheaper is it to ship 1500 lbs. of old household furniture, value limited to $5 per hundred pounds in case of loss, than to ship the same weight of new furniture set up? Than to ship the same weight of new furniture not set up?

52. What is the cost of shipping one car-load (20,000 lbs.) of old furniture? How many pounds of the same goods shipped by the hundred will it take to cost the same for freight?

53. What is the difference in freight cost between 200 lbs. of empty barrels and the same weight of trunks of baggage?

54. What is the difference in cost of freight on a ton (2000 lbs.) of canned vegetables and the same weight not canned?

55. What is the difference in cost between a car-load (24,000 lbs.) of canned vegetables and the same weight sent in two separate shipments, *i.e.*, by the hundredweight?

56. What is the difference in freight cost between 1900 lbs. of apples in baskets and the same weight in barrels?

57. Which costs the most, the freight on 1700 lbs. of flour or on 1700 lbs. of wheat?

The express charge between the points for which freight rates were given above is 25 cts. for less than 1 lb., 35 cts. from 1 to 2 lbs., 45 cts. from 2 to 3 lbs., 55 cts. from 3 to 4 lbs., 60 cts. from 4 to 5 lbs., 70 cts. from 5 to 7 lbs., 75 cts. from 7 to 10 lbs., 85 cts. from 10 to 15 lbs., $1.00 from 15 to 20 lbs., $1.10 from 20 to 25 lbs., $1.15 from 25 to 50 lbs., $2.30 from 50 to 100 lbs., and $2.30 per hundred for weights greater than 100 lbs.

58. What will be the difference of cost for a 200-lb. trunk shipped by express and by freight?

59. What will be the difference between freight and express charges on 300 lbs. of apples in baskets?

60. Which will be the cheaper way to ship a suit of clothes weighing, when boxed, 11 lbs.? How much cheaper?

61. Pupils may add problems concerning produce shipped to or from their nearest freight and express offices.

DIVISORS AND MULTIPLES

85. Name two factors of 18, 25, 32, 81, 120.

Name three factors of 18, 30, 45, 50, 66.

Name a factor common to 12 and 36.

If 3 is taken as one of the factors of 18, what is the other factor? How is the second factor found?

The process of separating a number into its factors is called **Factoring**.

86. An exact **Divisor** of a number is a factor of that number.

87. A factor or a divisor that is common to two or more numbers is called a **Common Divisor**.

EXERCISE 44. — ORAL

Find a common divisor:

1. 35, 45, 60.	**5.** 63, 72, 81.	**9.** 32, 48, 64.
2. 21, 35, 70.	**6.** 45, 24, 54.	**10.** 27, 36, 75.
3. 12, 24, 36.	**7.** 15, 30, 36.	**11.** 12, 18, 22.
4. 36, 28, 72.	**8.** 18, 24, 54.	**12.** 72, 81, 96.

88. Name all the factors or exact divisors of 3, 7, 19. A number that has no factors or divisors except itself and 1 is called a **Prime Number**, *e.g.*, 7, 11, 19, are prime numbers.

89. Factors that are prime numbers are called **Prime Factors**.

90. A number not a prime number is called a **Composite Number.**

91. Which of the following numbers are exactly divisible by 2 or have 2 as a factor: 2, 4, 6, 9, 11, 13, 14, 15, 16, 17, 21, 22, 27, 30?

92. Every number which contains the factor 2 is called an **Even Number.**

93. Numbers that are not divisible by 2 are called **Odd Numbers.**

94. Numbers that have no common factors are said to be **prime to each other.**

EXERCISE 45. — WRITTEN

1. Write a list of all prime numbers below 100.

2. Write a list of all odd numbers below 100.

3. Write all the exact divisors of all the numbers from 1 to 50.

4. Separate the following into prime factors: 4, 5, 7, 8, 10, 12, 13, 14, 16, 18, 21, 24, 25, 30, 34, 36.

5. Separate the prime, composite, even, and odd numbers in the following, and give reasons for your answers: 1, 6, 7, 10, 11, 12, 14, 19, 21, 24, 26, 27, 32, 33.

6. Write a list of the numbers from 2 to 50 that contain 2 as a factor. What do you note regarding the units' figure of each number?

7. Write a list of the numbers from 5 to 100 that contain 5 as a factor. What do you note regarding the units' figure in each case?

8. Write a list of the numbers from 3 to 60 which contain 3 as a factor. What do you note regarding the sum of the figures or digits of each number?

9. Write a list of the numbers from 9 to 90 that contain 9 as a factor, and find whether 9 is exactly contained in the sum of the digits of each of these numbers.

95. A number is divisible:

by 2 if the units' figure is 2, 4, 6, 8, or 0;
by 3 if the sum of its digits is divisible by 3;
by 4 if the number represented by the two right-hand figures is so divisible;
by 5 if the units' figure is 5 or 0;
by 8 if the number represented by the three right-hand figures is so divisible;
by 9 if the sum of its digits is so divisible.

96. Find the prime factors of 720.

$$\begin{array}{r|r} 5 & 720 \\ \hline 2 & 144 \\ \hline 2 & 72 \\ \hline 2 & 36 \\ \hline 2 & 18 \\ \hline 3 & 9 \\ \hline & 3 \end{array}$$

According to divisibility test 5 is a factor. 2 is a second, third, fourth, and fifth factor, 3 is the last factor. Hence, the prime factors of 720 are 5, 2, 2, 2, 2, 3, and 3.

EXERCISE 46. — WRITTEN

Find the prime factors of:

1. 670.	5. 420.	9. 385.	13. 321.
2. 981.	6. 462.	10. 297.	14. 335.
3. 310.	7. 741.	11. 2430.	15. 378.
4. 2650.	8. 1575.	12. 1215.	16. 10,935.

97. The greatest factor or divisor that is common to two or more numbers is called the **Greatest Common Divisor** (G. C. D.).

98. Find the G. C. D. of 24 and 30.

$24 = 2 \times 3 \times 4$
$30 = 2 \times 3 \times 5$

We find that the common factors of 24 and 30 are 2 and 3. Multiplying these common factors gives the G. C. D. Therefore, $2 \times 3 = 6$ is the G. C. D.

99. Rule. To find the G. C. D. of two or more numbers, separate the numbers into their prime factors and find the product of the prime factors that are common to all the numbers.

EXERCISE 47. — WRITTEN

Find the G. C. D.:

1. 14 98, 112.	6. 13, 91, 136.
2. 60, 120, 150.	7. 32, 48, 128.
3. 28, 42, 36.	8. 45, 72, 81.
4. 24, 30, 36.	9. 24, 80, 96.
5. 21, 28, 77.	10. 44, 77, 121.

100. When it is required to find the G. C. D. of two or more numbers that cannot readily be separated into prime factors, the following method may be employed.

Find the G. C. D. of 63 and 217.

```
63)217(3
   189
    28)63(2
       56
        7)28(4
          28
```

The G. C. D. is 7.

101. Rule. Divide the greater number by the smaller and the divisor by the remainder; continue the process until there is no remainder. The last divisor will be the G. C. D.

EXERCISE 48. — WRITTEN

Find the G. C. D. of:

1. 144, 576.	8. 6004, 3318.
2. 720, 144.	9. 1820, 3367.
3. 98, 112.	10. 1485, 1155, 1750.
4. 720, 1728.	11. 1254, 2361, 8163.
5. 820, 697.	12. 125, 175, 1792.
6. 1086, 905.	13. 1024, 1280, 1792.
7. 1220, 2013.	14. 315, 2267, 9012.

102. If 6 is multiplied by 3, the product is 18; 18 is called a **Multiple** of 6 and 3.

EXERCISE 49. — ORAL

Name two multiples of:

1. 7 and 5.	4. 8 and 2.	7. 7 and 6.	10. 3, 6, and 9.
2. 3 and 7.	5. 9 and 3.	8. 8 and 5.	11. 8, 6, and 4.
3. 6 and 3.	6. 10 and 4.	9. 9 and 2.	12. 9, 2, and 8.

103. A multiple of each of two or more numbers is called a **Common Multiple** of the numbers.

104. Of the common multiples of two or more numbers the least is called the **Least Common Multiple** (L. C. M.), *e.g.*, 18 is a common multiple of 3 and 6, but 12 is the least common multiple of these numbers.

105. Find the L. C. M. of 30 and 70.

$30 = 2 \times 3 \times 5$
$70 = 2 \times 5 \times 7$

The prime factors of 30 are $2 \times 3 \times 5$. The prime factors of 70 are $2 \times 5 \times 7$. To obtain a number which will contain both 30 and 70, the factors 2, 3, 5, 7, are selected, which multiplied together give 210, the L. C. M.

106. The following method of finding the L. C. M. of two or more numbers is also used. Find the L. C. M. of 30, 70, 18.

$$\begin{array}{r|rrr} 2 & 30 & 70 & 18 \\ \hline 5 & 15 & 35 & 9 \\ \hline 3 & 3 & 7 & 9 \\ \hline & 1 & 7 & 3 \end{array}$$

By multiplying together the final quotients and the divisors, $2 \times 5 \times 3 \times 7 \times 3$, we get 630, L. C. M.

107. Rule. To find the L. C. M. of two or more numbers, separate each number into its prime factors, and taking each factor the greatest number of times that it appears in any one of the given numbers, find the product of these factors.

EXERCISE 50.—WRITTEN

Find the L.C.M. of:

1. 5 and 15.
2. 9 and 12.
3. 21 and 36.
4. 8, 16, 64.
5. 24, 30, 36.
6. 9, 12, 50.
7. 36, 54, 63.
8. 17, 34, 51.
9. 21, 24, 26, 28.
10. 9, 10, 14, 15.
11. 7, 14, 56, 84.
12. 72, 66, 111.
13. 11, 22, 55, 110.
14. 8, 21, 28, 35.
15. 13, 15, 26, 39.
16. 4, 21, 42, 63.

DECIMAL FRACTIONS

EXERCISE 51. — ORAL

1. Name the smallest common silver coin in our money; name the largest silver coin.

2. The smallest silver coin is equal to what part of the largest?

3. Name the smallest coin in our money. The smallest coin is equal to what part of the smallest silver coin? Of the largest silver coin?

4. Read the following as dollars, dimes, and cents: \$3.33, \$4.44, \$5.55, \$6.66, \$7.77, \$9.99.

5. Read the following as dollars, tenths, and hundredths of a dollar: \$3.33, \$4.44, \$5.55, \$6.66, \$7.77, \$9.99.

EXERCISE 52. — WRITTEN

Write the following as cents, using the dollar sign:

1. 55 hundredths of a dollar.
2. 90 hundredths of a dollar.
3. 36 hundredths of a dollar.
4. 34 hundredths of a dollar.
5. 25 hundredths of a dollar.
6. 10 hundredths of a dollar.
7. 1 dollar and 10 hundredths.
8. 5 dollars and 15 hundredths.

108. As dollars may be divided into tenths and hundredths, so units of anything may be divided.

How many tenths of a thing are equal to 1 unit? To 10 units? To 100 units?

109. The division of units into tenths, hundredths, or thousandths is called **Decimal Division.**

110. The part of a unit obtained by decimal division is called a **Decimal Fraction.** Decimal fractions are commonly called **Decimals.**

111. The period placed at the left of tenths, *e.g.*, .2, is called the **Decimal Point.**

112. Decimal fractions may also be expressed thus: .2 or two-tenths. It may be also written $\frac{2}{10}$. When so written, the decimal fraction is expressed in the form of a **Common Fraction.**

113. The following table gives the names of the decimal places:

thousands	hundreds	tens	units	decimal point	tenths	hundredths	thousandths	ten-thousandths	hundred-thousandths	millionths
4	6	7	2	.	1	9	8	4	6	2

EXERCISE 53.—ORAL

Read the following:

1. 1.7.
2. 6.12.
3. 31.73.
4. 3.87.
5. 84.67.
6. 90.01.
7. 2.9.
8. 0.90.
9. 6.7.
10. 3.80.
11. 24.06.
12. 300.20.

EXERCISE 54. — ORAL

Name the place at the right of tenths, at the right of hundredths, at the right of thousandths, the fourth place, the fifth, the sixth, the seventh.

Read the following:

1. 15.004.	4. 0.0001.	7. 50.504.	10. 98.7256.
2. 25.102.	5. 1.4111.	8. 75.6281.	11. 100.2376.
3. 30.675.	6. 10.1063.	9. 86.5467.	12. 105.20068.

EXERCISE 55. — WRITTEN

Write in decimal form:

1. Five-tenths, three-tenths, four-tenths, one and one-tenth.

2. Six and eight thousandths, eight and forty-two thousandths, two ten-thousandths, ten millionths.

3. One hundred forty-five thousandths, three hundred eighty-one thousandths, four ten-thousandths, two hundred and two hundredths.

4. Five and six-tenths, nine and one-tenth, seventy-five hundredths, four hundred and four thousandths.

5. Write these common fractions as decimal fractions: $\frac{3}{10}$, $\frac{9}{10}$, $\frac{6}{10}$, $\frac{4}{100}$, $\frac{1}{100}$, $\frac{6}{1000}$, $\frac{9}{10000}$.

6. Distinguish between 0.300 and 0.00003.

7. Express as common fractions: 0.25, 0.250, 0.2500.

8. Annexing a cipher to a whole number increases its value how many times?

9. Does annexing a cipher to a decimal affect its value?

ADDITION OF DECIMALS

114. Add: 25.725, 62.8, 909.003, 4.23681.

```
 25.725
 62.8
909.003
  4.23681
```

Add decimals as in the addition of United States money. Place the decimal points in a vertical line, and add as in integral numbers.

EXERCISE 56. — WRITTEN

Find the sum of :

1. 5.47	2. 7.87	3. 112.63	4. 41.039
16.62	0.125	6.87	7.537
5.097	19.00	152.00	5.03
25.608	5.03	7.75	0.107

5. 19.083, 0.96, 5.03, 27.107, 5.1464, 0.905.

6. 489, 0.16, 0.49, 7.07, 5.0909, 0.0008.

7. 37.204, 3.1459, 143.59, 3415.18.

8. 6.2525, 62.525, 625.25, 6252.5.

9. Express as decimals and add: $\frac{3}{10}$, $\frac{30}{100}$, $\frac{300}{1000}$, $\frac{3}{100000}$, $3\frac{3}{10}$, $30\frac{30}{100}$, $300\frac{300}{1000}$.

EXERCISE 57. — WRITTEN

1. The amount of protein in pounds contained in 10 cts. worth of each of the following kinds of beef is as follows: tenderloin steak .064, sirloin steak .081, loin roast .090, rib roast .088, round steak, first cut., .130, round steak

.135, chuck .129, rump .114, shoulder .155, round, second cut, .205, neck .207, brisket .20, plate .230, flank .284, shank .256. I buy 10 cts. worth of each. Find the total amount of protein purchased; how much money do I spend?

2. The amount of protein found in 10 cts. worth of each of the following kinds of pork is: smoked ham .071, bacon .065, smoked shoulder .108, fresh ham .112, fresh shoulder .120, ribs and loin .134, fat salt pork .019. If I buy 10 cts. worth of each, how much protein do I buy? At what cost?

3. The amounts of protein in pounds found in 10 cts. worth of veal are as follows: cutlet .089, loin and rib .093, leg .098, shoulder and breast .18, chuck and neck .133, knuckle or shank .346, flank .424. Find the total amount of protein purchased if I buy 10 cts. worth of each of these cuts of veal. What does such a purchase cost?

4. The monthly rainfall at Davenport, Ia., a place of moderate rainfall, expressed in inches, was: 1.6, 1.6, 2.2, 2.7, 4.4, 4.1, 3.7, 3.6, 3.2, 2.4, 1.8, 1.6. What was the rainfall for the year?

5. The monthly rainfall at Mobile, Ala. (heavy), was: 4.8, 5.3, 7.4, 4.5, 4.2, 6.1, 6.7, 6.9, 4.9, 3.2, 3.5, 4.6. What was the yearly rainfall?

6. The monthly rainfall at Winnemora, Neb. (scant), was: 1.1, 0.9, 0.8, 0.9, 1.0, 0.6, 0.2, 0.2, 0.3, 0.5, 0.7, 1.2. What was the annual rainfall?

7. The monthly rainfall at Darjiling, India (excessive), was: 1, 1.5, 2, 6, 8, 16, 16, 16, 16, 6, 0.5, 0.5. What was the annual rainfall?

SUBTRACTION OF DECIMALS

115. From 9.25 take 7.075.

$$\begin{array}{r} 9.250 \\ \underline{7.075} \end{array}$$

If there are more decimal places in the subtrahend than in the minuend, annex ciphers until they have the same number of places.

EXERCISE 58. — WRITTEN

1. From 1.25 take 0.15.
2. From 7.75 take 1.95.
3. From 14.2 take 4.92.
4. From 14.2 take 4.92.
5. From 39. take 21.689.
6. From 500 take 9.32.
7. From 25.25 take 2.525.
8. From 37.18 take 9.189.
9. From 1.25 take $\frac{25}{100}$.
10. From $\frac{50}{100}$ take $\frac{25}{100}$.
11. From $\frac{50}{1000}$ take $\frac{25}{1000}$.
12. From $\frac{19}{1000}$ take $\frac{8}{1000}$.

EXERCISE 59. — WRITTEN

1. In 100 lbs. of wheat bran there are 15.4 lbs. of protein, 62.9 lbs. of carbohydrates, 4 lbs. of fats, 5.8 lbs. of ash, and the balance is water. How much water is there?

2. If in 100 lbs. of milk there are 4.32 lbs. of fat, 3.34 lbs. of protein, 5.7 lbs. of sugar, .74 lbs. of ash, and the balance is water, how much water is there?

3. If in 100 lbs. of cream there are 23.8 lbs. of fat, 4.12 lbs. of protein, 3.92 lbs. of sugar, 0.53 lb. of ash, and the balance is water, how much water is there?

4. If in 100 lbs. of timothy hay there are 13.2 lbs. of water, 4.4 lbs. of ash, 7.4 lbs. of carbohydrates, 2.5 lbs. of fats and the remainder is protein, how much protein is there?

5. If in 100 lbs. of red-clover hay there are 15.3 lbs. of water, 6.2 lbs. of ash, 62.9 lbs. of carbohydrates, 3.3 lbs. of fats, and the rest is protein, how much protein is there?

Nuts contain the following amounts of refuse and water in each pound. The refuse represents the shell and lining:

	Refuse	Water
Almonds	.45 lb.	.027 lb.
Beechnuts	.408 lb.	.023 lb.
Butternuts	.864 lb.	.006 lb.
Cocoanuts	.488 lb.	.072 lb.
Hickory nuts	.622 lb.	.014 lb.
Pecans	.532 lb.	.014 lb.
Walnuts	.741 lb.	.006 lb.
Peanuts	.245 lb.	.069 lb.

6. Which nuts contain most refuse? How much more than those of least refuse?

7. Which nuts contain most water? How much more than those of least water?

8. Which contain most nutritive matter? The amount not water and refuse is nutritive matter. How much more than those of least nutritive matter?

9. Find the amount of nutritive matter in each kind of nut.

MULTIPLICATION OF DECIMALS

EXERCISE 60.—ORAL

1. Read the following: .225, 2.25, 22.5, 225. How does moving the decimal point one place to the right affect the value of a number?

2. Read: .3720, 37.20, 3720. How does moving the decimal point two places to the right affect the value?

3. Read: .973, 973. How does moving the decimal point three places to the right affect the value?

116. Moving the decimal point one place to the right has the effect of multiplying the number by 10, two places by 100, three places by 1000, etc.

117. To multiply by 10, 100, 1000, etc., move the decimal point as many places to the right as there are ciphers in the multiplier, annexing ciphers at the right to complete the required number if necessary.

EXERCISE 61.—ORAL

1. Read the following: 675, 67.5, 6.75, .675. How does moving the decimal point one place to the left affect the value of the number?

2. Read: 22.70, 2270. How does moving the decimal point two places to the left affect the value?

3. Read: 325, .325. How does moving the decimal point three places to the left affect the value?

118. Moving the decimal point one place to the left has the effect of multiplying a number by one-tenth (0.1), two places by one one-hundredth (0.01), three places by one one-thousandth (0.001), etc.

119. To multiply by 0.1, 0.01, or 0.001 move the decimal point as many places to the left as there are decimal places in the multiplier, prefixing ciphers if necessary to complete the required number of decimal places.

EXERCISE 62. — WRITTEN

Multiply:

1. 49.68 by 10, by 100, by 1000.
2. 6297.3 by 10, by 100, by 1000.
3. 9.6847 by 10, by 100, by 1000.
4. 429673.0 by 10, by 100, by 1000.
5. 84910.0 by 10, by 100, by 1000.
6. 49.68 by 0.1, by 0.01, by 0.001.
7. 6297.3 by 0.1, by 0.01, by 0.001.
8. 9.6847 by 0.1, by 0.01, by 0.001.
9. 0.429673 by 0.1, by 0.01, by 0.001.
10. 84910 by 0.1, by 0.01, by 0.001.

120. Multiply 32.482 by 3.

$$\begin{array}{r} 32.482 \\ 3 \\ \hline 97.446 \end{array}$$

2 thousandths × 3 are 6 thousandths, the 6 is written under the thousandths. 8 hundredths × 3 are 24 hundredths, which equals 2 tenths and 4 hundredths. The hundredths are written under hundredths and the 2 tenths are to be added to tenths. 4 tenths × 3 are 12 tenths, which with 2 tenths are 14 tenths, which equal 1 unit and 4 tenths. 2 units × 3 are 6 units, which with 1 unit equal 7 units. 3 tens × 3 are 9 tens.

121. Multiply 32.482 by 0.3.

$$\begin{array}{r} 32.482 \\ 0.3 \\ \hline 9.7446 \end{array}$$

Multiply by 3 as if it were a whole number, pointing off 3 places in the product for the thousandths in the multiplicand and an additional place to indicate that the multiplicand has been multiplied by tenths. The product then has 4 decimal places.

122. To multiply decimal fractions multiply as with whole numbers. Point off as many places as there are decimals in the multiplier and multiplicand together. If the product does not contain as many decimal places as are required, prefix enough ciphers to make the required number.

EXERCISE 63.—WRITTEN

Multiply:

1. 96.0 by 0.3.
2. 9.6 by 0.3.
3. 0.96 by 0.3.
4. 132 by 2.47.
5. 13.2 by 24.7.
6. 0.132 by 247.0.
7. 9.06 by 1.24.
8. 0.236 by 8.93.
9. 0.259 by 0.247.
10. 349 by 0.46.
11. 4.39 × 0.74.
12. 5 .6 × .056.
13. 35.16 × 5.75.
14. 50.05 × 0.0095.
15. 184.2 × 0.098.
16. 214.86 × 45.64.
17. 37.55 × 0.00025.
18. 873.0 × 0.675.
19. 214.76 × 1.25.
20. 87.136 × 0.0042.
21. 897.28 × 2.009.

EXERCISE 64.—WRITTEN

1. If a bushel of corn on the ear weighs 70 lbs. and of each pound 0.2 is cobs, what is the weight of a bushel of shelled corn?

2. If in 1 lb. of corn stover there is 0.6 lb. of stalks,

0.3 lb. of leaves, and 0.1 lb. of shucks, how many pounds of each are there in 2000 lbs. of stover?

3. If in 1 lb. of commercial fertilizer there is 0.08 lb. of phosphoric acid, 0.025 lb. of nitrogen, and 0.035 lb. of potash, how many pounds of each are there in 100 lbs. of such commercial fertilizer? How many pounds of each in 2000 lbs.?

4. A housekeeper's Saturday grocery order was as follows: 6 lbs. roast at $0.18 a pound, 3 lbs. rice at $0.0825 a pound, 1 pk. sweet potatoes at $0.25 a peck, .5 lb. tapioca at $0.08 a pound, 1.25 lbs. cheese at $0.19 a pound, 10 lbs. graham flour at $0.03 a pound. Find total cost.

5. The average wheat yield to the acre in Great Britain is 33.9 bus., in the United States 14.5 bus., in India 9.2 bus., in Russia 10.2 bus. Russia grows 39,215,686 acres, the United States 33,766,233 acres, India 16,847,826 acres. If the yield per acre in the United States and Russia were brought up to that of Great Britain by skilful seed selection and tillage, what would be the increase to the world's wheat crop?

6. If the rainfall in India were sufficient, the yield per acre there might be equal to that in Great Britain. What would the total yield of India then be?

7. What does it cost to travel 198 miles at 2.5 cts. per mile? At 2.25 cts.? At 3.75 cts.?

8. The distance round a wheel is 3.1416 times its height. What is the distance round a wheel 4.75 feet high? Round a 28-in. wheel?

DIVISION OF DECIMALS

123. Divide $40.00 by $10.00, $40.00 by 10 cts., $75.00 by $15.00, $75.00 by 15 cts. Compare the results.

We have seen that United States money is written as a decimal fraction, *e.g.*, $1 and 10 cts. is written $1.10.

In the division of United States money when the divisor is represented by cents, both divisor and dividend are changed to cents, and the division is performed as with integers.

124. Divide 8.75 by 2.5.

$$\begin{array}{r} 3.5 \\ 25\overline{)87.5} \\ 75 \\ \hline 12.5 \\ 12.5 \\ \hline \end{array}$$

2.5 multiplied by 10 is changed to the integer 25. 8.75 multiplied by 10 is changed to 87.5. Dividing as in United States money, $87 \div 25 = 3$, with a remainder of 12. Adding .5 to the remainder gives 12.5 for a new partial dividend. $12.5 \div 25 = .5$. Therefore, the quotient is 3.5.

To divide a decimal fraction, multiply both dividend and divisor by 10, or such multiple of 10 as shall make the divisor an integer; then divide as in United States money.

EXERCISE 65.—WRITTEN

Find the quotient of:

1. $7.75 \div 25$. **3.** $7.75 \div .25$. **5.** $7.75 \div .0025$.

2. $7.75 \div 2.5$. **4.** $7.75 \div .025$. **6.** $7.75 \div .00025$.

7. $17280 \div 125$.
8. $17280 \div 12.5$.
9. $17280 \div 1.25$.
10. $17280 \div .125$.
11. $17280 \div .00125$.
12. $17280 \div .0125$.

125. Divide 10.10 by 10, divide 100.100 by 100, divide 1000.1000 by 1000. Compare these results.

In preceding pages you have seen that moving a figure one place to the **right** in its period decreases its value tenfold. In like manner, the removal of the decimal point one place to the **left** decreases a number tenfold, or divides the number by 10. Hence, to divide a decimal by 10, 100, 1000, etc., remove the decimal point as many places to the left as there are ciphers in the divisor. When necessary, add ciphers to complete the required number of places.

EXERCISE 66.—WRITTEN

Find the quotient of:

1. $3725.4 \div 70$.
2. $309.45 \div 1500$.
3. $132.4 \div 4000$.
4. $810.18 \div 9000$.
5. $810.18 \div 0.009$.
6. $7325.1 \div 1.045$.

126. When there is a remainder after using all the figures of the dividend, annex ciphers to the dividend and continue the division. For ordinary affairs in business it is not necessary to carry the division further than four or five decimal places.

EXERCISE 67.—WRITTEN

Find the quotient of:

1. $92323.15 \div 6.275$.
2. $281.8585 \div 3.85$.
3. $725.406 \div 6956$.
4. $281.85 \div 3.85$.
5. $87.912 \div 4.07$.
6. $0.375 \div .25$.

7. $317.25 \div 75$.
8. $0.0125 \div 2.5$.
9. $1361.5 \div 500$.
10. $50 \div .25$.
11. $874.298 \div 62.85$.
12. $600982 \div 3.2909$.
13. $7.847 \div .03962$.
14. $849.27 \div 38.0099$.
15. $3.42981 \div 2.86008$.
16. $8498.762 \div 678.9084$.

EXERCISE 68. — WRITTEN

1. If 100 lbs. of milk yield 5.452 lbs. of butter, how much butter will 1 lb. yield?

2. If a gallon of milk weighs 8.6 lbs., how much butter will 2 gallons of milk of the quality mentioned in the last problem produce?

3. If the corn plants on an acre weigh 7450 lbs., and in each pound there are .417 lb. of ears and .583 lb. of stover, how many bushels of ear corn, allowing 70 lbs. to the bushel, are there, and how many pounds of stover?

4. Seven pigs, averaging 28.10 lbs., gained in 6 weeks 503 lbs. per acre of peanut pasture used. What was the gain of each animal for each day? If the increase was worth 6 cts. a pound, what value per acre was derived from the pasture?

5. Five pigs, aggregating 895 lbs., pastured 20 days on Spanish peanuts, weighed at the end of that time 1124 lbs. What was the gain for each animal in the 20 days? What was the gain for each day? At 6 cts. a pound, what was the increase in value?

EXERCISE 69. — WRITTEN

The pupil should practise with decimals enough to attain proficiency.

	a	*b*	*c*	*d*	*e*	*f*	*g*
1	379.421	2.469	24.378	23.428	2.267	1.479	*h*
2	387.463	4.28	368.0	7.29	0.39	0.009	*i*
3	289.4	0.796	398.42	97.0	78.4	0.379	*j*
4	63.0	62.97	798.4	629.18	32.007	3.6298	*k*
5	78.4	17.843	6829.45	43.978	67.08	1.982	*l*
6	8.629	0.08976	0.7842	3692.0	0.0079	3.479	*m*
7	0.0078	0.42963	67.0	47.961	7900.0	0.062	*n*
8	76.24	0.0098	8.0009	692.0	6239.5	0.398	*o*
9	872.98	7.627	764.02	798.42	78.42	3.429	*p*
10	642.87	8.429707	7.9628	68.394	86.39	6.729	*q*
	11	**12**	**13**	**14**	**15**	**16**	

1–6. Add columns *a*, *b*, *c*, *d*, *e*, *f*.

7–16. Add the numbers in line 1, 2, etc., to 10.

17–27. Subtract from the first number in column *d* each number in column *f*.

28–116. Subtract from each other number in column *d* each number in column *f*.

117–216. Multiply each number in column *c* by each number in column *e*.

217–316. Divide each number in column *a* by each number in column *b*.

EXERCISE 70.—WRITTEN

Review Problems

1. If a bushel of corn contains 5.88 lbs. of protein, 40.15 lbs. of carbohydrates, and 3.024 lbs. of fats, what is a bushel of corn worth for feeding at 3.7 cts. a pound for protein, .5 ct. a pound for carbohydrates, and 3.1 cts. a pound for fats.

2. The different items of cost to build a stave silo 12 ft. in diameter and 21 ft. high are as follows: hauling rock \$3, hauling sand \$1, cement 4.75 barrels at \$2.85 per barrel, putting in concrete foundation, 1 man, 4 days at \$1.25 a day, lumber \$5, staves \$28.84, hauling lumber \$3, nails 25 lbs. at 3 cts., nails 10 lbs. at $3\frac{1}{2}$ cts., hoops \$21.95, bolts 45 cts., small bolts 30 cts., tar, gasoline, and brush \$1.40, tar paper 2 rolls at \$1.375, carpenter 6 days at \$1.75 a day, labor 2 days at \$1 a day. What was the total cost of building the silo?

3. If a field of cotton yields 4793 lbs. of seed cotton and each pound yields .314 lb. of lint, how many pounds of seed and how many pounds of lint are there?

4. To make 1 lb. increase in weight in pigs pastured on peanuts required 1.77 lbs. of grain, when pastured on chufas 2.3 lbs. of grain, when on cow-peas 3.07 lbs. of grain, when on sweet potatoes, 3.13 lbs. of grain, when on sorghum 3.70 lbs. of grain. How many more pounds of grain were required when on chufas than when on peanut pasturage? How many more when on cow-peas than when on peanuts? When on sorghum than when on peanuts? When on sorghum than when on sweet potatoes?

5. The following is the average yield of wheat per acre in the principal wheat-growing nations of the world: Great Britain 33.9 bushels, Germany 28.6, France 20.8, Hungary 18.4, Austria 19.6, United States 14.5, and Russia, 10.2. How many acres would it require in each of the other countries mentioned to produce as much wheat as is produced on 1 acre in Great Britain?

6. The following shows the cost and benefit from spraying Irish potatoes for several years in New York:

Year	Total Acres Sprayed	Increase in Yield, Bushels per Acre	Cost of Spraying per Acre	Profit from Spraying
1903	61.2	57.0	$4.98	——
1904	180.0	62.2	4.98	——
1905	160.7	46.5	4.25	——
1906	225.6	42.6	5.18	——
Total				——

What was the average cost of spraying per acre? Valuing potatoes at 57 cts. a bushel, what was the average profit per acre from spraying?

7. The items of expense for spraying 10.4 acres of potatoes 5 times are: 234 lbs. of copper sulphate at 7 cts., 195 lbs. of prepared lime at 1.5 cts., 90 quarts of arsenite of soda solution at 25 cts., 70 hours' labor for man and horse at 30 cts., wear on tools, $6.50. What is the cost of spraying each acre for each application?

8. In 100 lbs. red-clover hay there are the following constituents: 15.3 lbs. water, 6.2 lbs. ash, 62.9 lbs. carbohydrates, 3.3 lbs. fats, and the balance is protein. In 100 lbs. of timothy hay there are 13.2 lbs. water, 4.4 lbs. ash, 74 lbs. carbohydrates, 2.5 lbs. fats, and the balance is protein. How many more pounds of protein are there in 2000 lbs. of clover hay than in 2000 lbs. of timothy hay?

9. If 100 lbs. of green cow-peas contain 1.7 lbs. of ash, 2.4 lbs. of protein, 11.9 lbs. of carbohydrates, .4 lb.

of fats, and the balance is water, how many pounds of water are there in 1000 lbs. of fresh cow-peas?

10. In buying redtop grass seed at 13.7 cts. a pound when only 77 lbs. in every 100 lbs. is good live seed, what is the price paid per pound for good seed?

11. With redtop seed at 8.54 cts. a pound containing 11 lbs. of good seed in every 100 lbs., what is the price per pound of the good seed?

12. With blue-grass seed at 14 cts. a pound containing 60 lbs. of good seed in every 100 lbs., what is the price per pound of the good seed?

13. With blue-grass seed at 10 cts. a pound containing .4 lb. of good live seed to the hundred pounds, what is the price per pound of the good seed?

14. With timothy grass seed containing 96 lbs. per hundred of good seed bought at $1.60 a bushel, what is the price paid per bushel for good seed?

15. If a cow produces 7446 lbs. of milk in a year and 1 lb. of milk produces .059 lb. of butter, how many pounds of butter does the cow produce, and what is it worth at 27 cts. a pound?

16. How much does the butter cost per pound in value of feed, if she ate 12.4 cts. worth each day?

17. Another cow gave 3400 lbs. of milk, and each pound of milk produced .0406 lb. of butter. Did this cow make a profit with butter at 27 cts. if the cost of feed was 11.2 cts. a day?

18. If 1 pound of cotton-seed meal contains .0618 lb. of nitrogen, .018 lb. of potash, and .028 lb. of phosphoric

acid, how much of each of these fertilizing materials does a ton, or 2000 lbs., of cotton-seed meal contain? What is the ton of cotton-seed meal worth for fertilizing at 18 cts. a pound for nitrogen, 4 cts. for phosphoric acid, and 5 cts. for potash?

19. If 1 pound of cotton-seed contains .031 lb. of nitrogen, .013 lb. of phosphoric acid, .012 lb. of potash, what is the ton of seed worth at the same prices for fertilizing materials as in problem 18?

20. The following are the plant-food constituents which a farmer sells from his farm in the products named:

	Nitrogen	Phosphoric Acid	Potash
3000 lbs. milk	15.9 lbs.	5.7 lbs.	5.4 lbs.
140 lbs. butter	02.8 lbs.	0.42 lb.	0.35 lb.
500 lbs. cotton lint	01.7 lbs.	0.5 lb.	2.3 lbs.
1000 lbs. cotton-seed	31.0 lbs.	13.0 lbs.	12.0 lbs.
20 bus. wheat	28.32 lbs.	9.48 lbs.	6.0 lbs.
40 bus. corn	40.57 lbs.	15.68 lbs.	8.96 lbs.
1.5 tons timothy hay	37.8 lbs.	15.9 lbs.	27.0 lbs.

Valuing nitrogen at 18 cts. a pound, phosphoric acid at 4 cts. a pound, and potash at 5 cts. a pound, what is the value of the fertilizing materials removed from the farm by the sale of each of these products in the amounts indicated?

COMPOSITION OF FOODS

21. If for 10 cts. I can purchase .064 lb. of protein in tenderloin steak, how much protein do I obtain in 50 cts. worth of tenderloin?

22. If for 10 cts. I can purchase .135 lb. of protein in

round steak, in which do I get most protein for the money, in tenderloin or in round steak? How much more?

A Good Loin Cut of Beef

23. If for 10 cts. I can purchase .03 lb. of protein in oysters, how much protein do I obtain in 70 cts. worth of oysters? In which of the above articles do I obtain most protein for my money?

24. In the following dairy products these amounts of protein may be purchased for 10 cts.: butter .004 lb., cheese .163 lb., whole milk .110 lb., skimmed milk .203 lb., cream .034 lb. How much protein in each may I obtain for 75 cts.?

LEGUMES

25. If each pound of vetch hay contains .17 lb. of nitrogen, how many pounds of nitrogen are there in 2879 lbs. of vetch hay? Each pound of alfalfa contains .143 lb. of nitrogen. How many pounds are there in 2879 lbs. of alfalfa? Each pound of red clover contains .123 lb. of

nitrogen. How many pounds are there in 2879 lb. of red clover? Each pound of cow-pea hay contains .166 lb. of nitrogen. How many pounds are there in 2879 lbs. of cow-pea hay? What is the value of the nitrogen in each of the above instances at 19 cts. a pound?

26. If 5953 lbs. of velvet-bean hay are grown on an acre, and in every pound of this hay there is .0221 lb. of nitrogen, how many pounds of nitrogen are gathered by the crop, and what is it worth at 18 cts. a pound?

27. If there is .024 lb. of nitrogen in 1 lb. of cow-pea hay, and 3000 lbs. of hay are made on an acre, what will be the value of the nitrogen collected by the crop, with nitrogen worth 18 cts. a pound, if for each pound of nitrogen in the hay there is left in the stubble and roots .3 lb. of nitrogen?

28. Crown Jewel potatoes dug in Virginia 80 days after planting yielded 170 bus., dug at 93 days after planting, the same variety gave 255 bus. What was the average increase daily during the additional period?

29. Beauty of Hebron potatoes dug in Virginia at 101 days after planting showed an increase of 136 bus. over those dug 80 days after planting. What was the average increase per day during the additional time?

30. Using nitrate of soda on clover, 300 lbs. to the acre, at $2.66 a hundred pounds, the yield was increased from 2.09 to 2.8 tons per acre, valued at $9 a ton in the field. Did the use of the fertilizer pay? What was the gain or loss per acre?

COMMON FRACTIONS

EXERCISE 71. — ORAL

1. How many weeks in a month? One week is equal to what part of a month? Two weeks are equal to what part of a month? Three weeks are equal to what part of a month?

2. One week is equal to what part of two months? One week is equal to what part of three months?

3. Two weeks are equal to what part of two months? Two weeks are equal to what part of three months?

4. Three weeks are equal to what part of two months? Three weeks are equal to what part of three months?

5. If a unit is divided into two equal parts, what is one part called? If a unit is divided into three equal parts, what is one part called? If into four, six, ten?

127. One or more of the equal parts of a unit is called a **Fraction.**

128. A fraction is expressed by two numbers, one written above the other, with a line between them; *e.g.*, one-fourth is expressed thus, $\frac{1}{4}$.

129. Read the following: $\frac{1}{2}$, $\frac{1}{6}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{10}$, $\frac{1}{20}$. What part of these fractions shows the number of parts into which the unit is divided?

The number which shows into how many parts a unit

is divided is called the **Denominator** ; *e.g.*, in the fraction $\frac{5}{6}$, 6 is the denominator and shows that a unit has been divided into six equal parts.

130. Which is greater, $\frac{1}{3}$ or $\frac{2}{3}$?

What does the number above the line indicate?

The number which shows how many parts are taken is called the **Numerator**; *e.g.*, in the fraction $\frac{3}{4}$, 3 is the numerator and shows that the fraction contains three of four equal parts.

131. The numerator and denominator are called the **Terms** of a fraction.

132. A fraction whose numerator is less than its denominator is called a **Proper Fraction**; *e.g.*, $\frac{3}{4}$, $\frac{6}{7}$, $\frac{8}{9}$, $\frac{7}{11}$, are proper fractions.

A proper fraction is always less than a unit.

133. A fraction in which the numerator is equal to or greater than the denominator is called an **Improper Fraction**; *e.g.*, $\frac{4}{4}$, $\frac{7}{4}$, $\frac{9}{8}$, are improper fractions. An improper fraction is always equal to or greater than a unit.

134. A whole number and a fractional number written together is called a **Mixed Number**; *e.g.*, $3\frac{1}{2}$, $7\frac{1}{8}$, are mixed numbers.

EXERCISE 72. — ORAL

Select proper fractions, improper fractions, and mixed numbers from the following:

1. $\frac{1}{3}$, $\frac{1}{8}$, $\frac{5}{6}$, $\frac{8}{9}$.
2. $\frac{7}{4}$, $\frac{2}{3}$, $3\frac{1}{8}$, $\frac{16}{14}$.
3. $\frac{19}{20}$, $\frac{18}{15}$, $\frac{3}{7}$, $\frac{7}{3}$.
4. $9\frac{1}{6}$, $\frac{9}{2}$, $18\frac{1}{2}$, $\frac{4}{5}$.
5. $\frac{5}{4}$, $\frac{13}{16}$, $\frac{8}{5}$, $\frac{1}{25}$.
6. $\frac{25}{3}$, $9\frac{2}{7}$, $16\frac{3}{4}$, $\frac{9}{10}$.
7. $3\frac{9}{10}$, $6\frac{2}{3}$, $1\frac{1}{2}$, $\frac{36}{9}$.
8. $\frac{20}{19}$, $\frac{15}{4}$, $9\frac{1}{32}$, $\frac{56}{47}$.
9. $\frac{28}{39}$, $\frac{19}{5}$, $5\frac{1}{2}$, $\frac{16}{24}$.

EXERCISE 73. — WRITTEN

Write as common fractions or mixed numbers:

1. Thirty-one tenths.
2. Fifty-six elevenths.
3. Eight-nineteenths.
4. Seven-fifteenths.
5. Eight one-hundredths.
6. Ninety and three-fourths.
7. One hundred and forty-five forty-sixths.
8. Seventy-seven and six-tenths.
9. Five hundred tenths.
10. Twenty-five thirty-sixths.
11. Nineteen and seven twenty-firsts.
12. Twenty-one and eighteen nineteenths.
13. One hundred twenty-five and one hundred twenty-four one hundred twenty-fifths.

EXERCISE 74. — WRITTEN

Write in words:

1. $\frac{6}{7}$, $\frac{8}{9}$, $\frac{5}{19}$.	6. $666\frac{2}{3}$, $25\frac{4}{5}$.
2. $\frac{15}{16}$, $\frac{39}{27}$, $\frac{18}{45}$.	7. \$7.12$\frac{1}{2}$, \$12.25$\frac{1}{4}$.
3. $\frac{18}{24}$, $\frac{47}{56}$, $\frac{7}{9}$.	8. \$266.26$\frac{2}{3}$, \$19.18$\frac{1}{2}$.
4. $1\frac{2}{3}$, $25\frac{2}{3}$, $\frac{7}{160}$.	9. $1\frac{3}{4}$, $\frac{8}{15}$, $\frac{99}{3}$, $\frac{1000}{1}$.
5. $9\frac{3}{32}$, $150\frac{7}{8}$.	10. $\frac{7}{55}$, $\frac{58}{57}$, $\frac{17}{5}$, $19\frac{6}{7}$.

135. An improper fraction may be regarded as an indicated division, *e.g.*, $\frac{13}{4}$ indicates that each of several units has been divided into 4 parts; 13 of these parts are here

represented. To find how many units are represented by $\frac{13}{4}$, we may regard 13 as the dividend and 4 as the divisor; $13 \div 4 = 3$ whole units and $\frac{1}{4}$ of a unit.

136. To change an improper fraction to a whole or mixed number, divide the numerator by the denominator.

EXERCISE 75.—WRITTEN

Change to whole or mixed numbers:

1. $\frac{42}{7}$.	**4.** $\frac{47}{6}$.	**7.** $\frac{92}{12}$.	**10.** $\frac{70}{11}$.	**13.** $\frac{77}{77}$.
2. $\frac{15}{3}$.	**5.** $\frac{127}{25}$.	**8.** $\frac{81}{8}$.	**11.** $\frac{580}{36}$.	**14.** $\frac{1728}{12}$.
3. $\frac{18}{3}$.	**6.** $\frac{63}{7}$.	**9.** $\frac{318}{9}$.	**12.** $\frac{693}{420}$.	**15.** $\frac{269}{17}$.

137. A whole number or a mixed number may be represented in the form of an improper fraction, *e.g.*, 8 may be expressed in halves, as $\frac{16}{2}$; $8\frac{1}{2}$ may be expressed as halves, thus, $\frac{17}{2}$.

Since one unit contains 2 halves, 8 units contain $\frac{16}{2}$. $\frac{16}{2}$ and $\frac{1}{2}$ equals $\frac{17}{2}$.

138. To change a mixed number to an improper fraction, multiply the whole number by the denominator and add the numerator; write the sum over the denominator.

EXERCISE 76.—WRITTEN

Change to improper fractions:

1. $12\frac{1}{2}$.	**5.** $10\frac{3}{17}$.	**9.** $17\frac{6}{11}$.	**13.** $45\frac{3}{11}$.
2. $15\frac{1}{3}$.	**6.** $25\frac{4}{5}$.	**10.** $12\frac{15}{61}$.	**14.** $17\frac{29}{84}$.
3. $18\frac{2}{9}$.	**7.** $33\frac{1}{3}$.	**11.** $72\frac{31}{48}$.	**15.** $167\frac{39}{68}$.
4. $45\frac{3}{12}$.	**8.** $19\frac{1}{8}$.	**12.** $25\frac{7}{30}$.	**16.** $167\frac{29}{84}$.

EXERCISE 77. — ORAL

1. How many twelfths in one unit?

2. How many twelfths in two units?

3. How many twelfths in one-half unit?

4. How many twelfths in one-third unit?

5. What is true of the value of $\frac{6}{12}$ and $\frac{1}{2}$? What is true of the terms of the second fraction?

6. Does changing $\frac{6}{12}$ to the lower terms, $\frac{1}{2}$, change the value?

EXERCISE 78. — WRITTEN

Change the following to lower terms:

1.	$\frac{3}{6}$, $\frac{8}{16}$, $\frac{6}{12}$, $\frac{9}{18}$.	6.	$\frac{7}{21}$, $\frac{8}{24}$, $\frac{10}{30}$.
2.	$\frac{3}{9}$, $\frac{6}{18}$, $\frac{5}{15}$.	7.	$\frac{18}{27}$, $\frac{15}{60}$, $\frac{24}{72}$.
3.	$\frac{3}{12}$, $\frac{2}{8}$, $\frac{6}{24}$.	8.	$\frac{19}{38}$, $\frac{51}{102}$, $\frac{18}{81}$.
4.	$\frac{5}{20}$, $\frac{6}{8}$, $\frac{4}{16}$.	9.	$\frac{108}{144}$, $\frac{17}{51}$, $\frac{14}{70}$.
5.	$\frac{6}{30}$, $\frac{5}{25}$, $\frac{9}{45}$.	10.	$\frac{16}{48}$, $\frac{22}{66}$, $\frac{19}{95}$.

139. A fraction is reduced to its **Lowest Terms** when the terms are prime to each other.

To reduce a fraction to lowest terms, select factors common to both terms, and cancel.

EXERCISE 79. — WRITTEN

Reduce to lowest terms:

1.	$\frac{35}{45}$.	5.	$\frac{125}{500}$.	9.	$\frac{44}{52}$.	13.	$\frac{380}{1980}$.
2.	$\frac{15}{55}$.	6.	$\frac{26}{39}$.	10.	$\frac{63}{217}$.	14.	$\frac{216}{648}$.
3.	$\frac{27}{57}$.	7.	$\frac{72}{144}$.	11.	$\frac{147}{189}$.	15.	$\frac{344}{552}$.
4.	$\frac{80}{95}$.	8.	$\frac{63}{69}$.	12.	$78\frac{4}{16}$.	16.	$\frac{168}{224}$.

EXERCISE 80.—ORAL

1. Express $\frac{1}{2}$ as 4ths.
2. Express $\frac{3}{4}$ as 8ths.
3. Express $\frac{5}{6}$ as 12ths.
4. Express $\frac{2}{7}$ as 14ths.
5. Express $\frac{2}{7}$ as 28ths.
6. Express $\frac{1}{2}$, $\frac{1}{4}$ as 8ths.
7. Express $\frac{1}{2}$, $\frac{3}{4}$, $\frac{1}{12}$ as 12ths.
8. Express $\frac{1}{3}$, $\frac{3}{4}$, $\frac{5}{6}$ as 12ths.
9. Express $\frac{2}{3}$, $\frac{5}{6}$, $\frac{1}{8}$ as 24ths.
10. Express $\frac{1}{5}$, $\frac{3}{4}$, $\frac{1}{10}$ as 20ths.

EXERCISE 81.—WRITTEN

Express as fractions with the same denominator:

1. $\frac{1}{4}$, $\frac{1}{8}$.
2. $\frac{1}{3}$, $\frac{1}{12}$.
3. $\frac{1}{8}$, $\frac{1}{3}$.
4. $\frac{1}{7}$, $\frac{1}{3}$.
5. $\frac{1}{6}$, $\frac{1}{8}$.
6. $\frac{1}{2}$, $\frac{1}{8}$.
7. $\frac{3}{4}$, $\frac{1}{12}$.
8. $\frac{1}{2}$, $\frac{5}{8}$.
9. $\frac{2}{3}$, $\frac{4}{9}$.
10. $\frac{2}{3}$, $\frac{3}{4}$.
11. $\frac{1}{3}$, $\frac{1}{6}$.
12. $\frac{3}{4}$, $\frac{2}{9}$.

140. If several fractions have the same denominator, they are said to be **Similar Fractions**, and the denominator is called a **Common Denominator.**

141. If the common denominators are the smallest possible, the fractions are said to have the Least Common Denominator (L. C. D.), *e.g.*, the fractions $\frac{6}{12}$ and $\frac{9}{12}$ have a common denominator 12, but they may be reduced to $\frac{2}{4}$ and $\frac{3}{4}$, 4 being the L. C. D.

142. Reduce $\frac{1}{3}$, $\frac{5}{8}$, $\frac{10}{12}$, to similar fractions with the least common denominator.

The common denominator of $\frac{1}{3}$, $\frac{5}{8}$, $\frac{10}{12}$, must be the least common multiple of the denominators 3, 8, 12.

We find that the L. C. D. of these numbers is 24. Change each fraction to 24ths by multiplying each denominator by the factor that will give 24, and multiplying the numerator by the same factor, thus:

$$\begin{array}{r|rrr} 2 & 3 & 8 & 12 \\ \hline 3 & 3 & 4 & 6 \\ \hline 2 & 1 & 4 & 2 \\ \hline & 1 & 2 & 1 \end{array}$$

To change $\frac{1}{3}$ to 24ths, multiply both numerator and denominator by $8 = \frac{1 \times 8}{3 \times 8} = \frac{8}{24}$.

To change $\frac{5}{8}$ to 24ths, multiply both numerator and denominator by $3 = \frac{5 \times 3}{8 \times 3} = \frac{15}{24}$.

To change $\frac{10}{12}$ to 24ths, multiply both numerator and denominator by $2 = \frac{10 \times 2}{12 \times 2} = \frac{20}{24}$.

143. In reducing fractions to a common denominator they are changed to **Higher Terms.**

EXERCISE 82. — WRITTEN

Reduce to similar fractions:

1. $\frac{1}{2}$, $\frac{3}{4}$.	3. $\frac{9}{21}$, $\frac{11}{30}$.	5. $\frac{6}{8}$, $\frac{9}{10}$.	7. $\frac{3}{4}$, $\frac{4}{15}$.
2. $\frac{5}{12}$, $\frac{6}{15}$.	4. $\frac{1}{7}$, $\frac{7}{21}$.	6. $\frac{4}{9}$, $\frac{2}{8}$.	8. $\frac{2}{5}$, $\frac{7}{10}$, $\frac{9}{20}$.

EXERCISE 83. — WRITTEN

Reduce to fractions having a L. C. D.:

1. $\frac{1}{4}$, $\frac{1}{5}$, $\frac{3}{10}$.	6. $\frac{12}{144}$, $\frac{9}{132}$.
2. $\frac{1}{2}$, $\frac{3}{8}$, $\frac{5}{12}$.	7. $\frac{5}{222}$, $\frac{13}{430}$.
3. $\frac{3}{5}$, $\frac{4}{7}$, $\frac{2}{3}$.	8. $\frac{9}{25}$, $\frac{7}{55}$.
4. $\frac{7}{8}$, $\frac{1}{5}$, $\frac{1}{40}$.	9. $\frac{9}{11}$, $\frac{8}{99}$, $\frac{5}{121}$.
5. $\frac{6}{30}$, $\frac{5}{45}$, $\frac{6}{15}$.	10. $\frac{4}{15}$, $\frac{11}{45}$, $\frac{17}{60}$.

EXERCISE 84. — WRITTEN

Change to improper fractions and reduce to L. C. D.:

1. $12\frac{3}{5}$, $18\frac{1}{4}$.	5. $63\frac{2}{27}$, $45\frac{11}{71}$.
2. $21\frac{4}{21}$, $36\frac{1}{28}$.	6. $42\frac{17}{18}$, $61\frac{25}{28}$.
3. $72\frac{7}{15}$, $26\frac{9}{45}$.	7. $81\frac{9}{32}$, $24\frac{7}{48}$.
4. $24\frac{5}{6}$, $36\frac{12}{72}$.	8. $16\frac{4}{65}$, $21\frac{11}{52}$.

ADDITION OF FRACTIONS

EXERCISE 85. — ORAL

1. How many tenths in $\frac{3}{10}+\frac{2}{10}$? How many fifths? 5

2. How many twelfths in $\frac{2}{12}+\frac{5}{12}$? How many fourths?

3. How many sixths in $\frac{1}{6}+\frac{7}{6}$? How many ones?

4. To find the sums of these fractions, what terms of the fractions are added?

5. How much is $\frac{1}{3}+\frac{1}{2}$? $\frac{1}{2}+\frac{1}{4}$? $\frac{1}{6}+\frac{1}{3}$? $\frac{3}{4}+\frac{1}{8}$? $\frac{2}{3}+\frac{1}{2}$?

6. To what kind of fractions must those above be changed before they can be added?

144. Add $\frac{4}{5}$, $\frac{5}{6}$, $\frac{9}{12}$.

First find the L. C. D. The L. C. D. is $5 \times 2 \times 3 \times 2 = 60$.

Reducing each fraction to higher terms with 60 for a common denominator, we have,

$$\frac{4 \times 12}{5 \times 12}=\frac{48}{60} \qquad \frac{5 \times 10}{6 \times 10}=\frac{50}{60} \qquad \frac{9 \times 5}{12 \times 5}=\frac{45}{60}$$

$\frac{48}{60}+\frac{50}{60}+\frac{45}{60}=\frac{143}{60}$. Reducing $\frac{143}{60}$ to a mixed number gives $2\frac{23}{60}$.

145. Add $3\frac{1}{6}+6\frac{7}{8}$.

The sum of $3+6=9$.

By finding the L. C. D. of $\frac{1}{6}$ and $\frac{7}{8}$ and changing these fractions to higher terms, we get $\frac{4}{24}+\frac{21}{24}=\frac{25}{24}$.

Changing $\frac{25}{24}$ to a mixed number gives $1\frac{1}{24}$.
Uniting the sums, $9+1\frac{1}{24}=10\frac{1}{24}$.

146. To add fractions, reduce to similar fractions having the L. C. D., and add the numerators, placing the sum over the common denominator. The answer should always be reduced to lowest terms.

EXERCISE 86.—WRITTEN

Find the sum of:

1. $\frac{1}{2}$, $\frac{2}{3}$.
2. $\frac{4}{5}$, $\frac{3}{5}$.
3. $\frac{6}{8}$, $\frac{5}{8}$, $\frac{8}{9}$.
4. $\frac{3}{7}$, $\frac{3}{4}$, $\frac{7}{21}$.
5. $6\frac{7}{8}$, $2\frac{1}{8}$.
6. $9\frac{1}{2}$, $2\frac{3}{4}$.
7. $\frac{4}{5}$, $3\frac{1}{2}$, $5\frac{5}{6}$.
8. $2\frac{3}{4}$, $9\frac{7}{12}$, $3\frac{5}{24}$.

EXERCISE 87.—WRITTEN

1. A boy spends $\frac{3}{8}$ of his money for a suit of clothes, $\frac{1}{4}$ for an overcoat, $\frac{1}{8}$ for a pair of shoes, and $\frac{1}{12}$ for a hat. What part of his money has he spent?

2. After making his purchases, he has left $\frac{1}{6}$ of his money, which is \$4. How much had he at first?

3. A girl's dress skirt is $26\frac{1}{2}$ ins. long when finished; if $\frac{1}{4}$ in. is allowed for gathers at the top and $2\frac{1}{2}$ ins. for the hem, how long must the material be cut for making?

4. If she wishes to add a ruffle $3\frac{1}{2}$ ins. wide, with an inch hem at the bottom, and a $\frac{3}{4}$-in. hem at the top, how wide must she cut the material for the ruffle?

5. How many yards of fencing will be required to fence an irregularly shaped school yard $23\frac{1}{5}$ yds., $42\frac{7}{8}$ yds., $40\frac{2}{9}$ yds., $27\frac{6}{7}$ yds. on the sides?

SUBTRACTION OF FRACTIONS

147. How much is $\frac{2}{3}+\frac{1}{3}$? How much is $\frac{2}{3}-\frac{1}{3}$?
How much is $\frac{2}{5}+\frac{1}{15}$? How much is $\frac{2}{5}-\frac{1}{15}$?
How much is $\frac{1}{6}+\frac{1}{12}$? How much is $\frac{1}{6}-\frac{1}{12}$?

To subtract fractions they must, as in addition, be changed to similar fractions. Subtract the numerator of the subtrahend from the numerator of the minuend to obtain the numerator of the difference, *e.g.*, $\frac{2}{5}-\frac{1}{10}=\frac{4}{10}-\frac{1}{10}$, or $\frac{3}{10}$.

EXERCISE 88.—ORAL

Find the value of:

1. $\frac{5}{6}-\frac{2}{6}$.	**4.** $\frac{11}{12}-\frac{1}{12}$.	**7.** $\frac{3}{18}-\frac{1}{9}$.
2. $\frac{3}{8}-\frac{1}{8}$.	**5.** $\frac{7}{12}-\frac{1}{4}$.	**8.** $\frac{7}{24}-\frac{1}{12}$.
3. $\frac{3}{5}-\frac{1}{5}$.	**6.** $\frac{11}{12}-\frac{3}{4}$.	**9.** $\frac{9}{14}-\frac{2}{7}$.

EXERCISE 89.—WRITTEN

Find the value of:

1. $\frac{5}{8}-\frac{1}{2}$.	**6.** $\frac{6}{7}-\frac{2}{3}$.	**11.** $\frac{2}{3}-\frac{5}{12}$.
2. $\frac{1}{2}-\frac{5}{12}$.	**7.** $\frac{13}{16}-\frac{3}{4}$.	**12.** $\frac{16}{33}-\frac{7}{30}$.
3. $\frac{3}{10}-\frac{1}{8}$.	**8.** $\frac{3}{8}-\frac{1}{4}$.	**13.** $\frac{19}{30}-\frac{1}{13}$.
4. $\frac{5}{12}-\frac{1}{36}$.	**9.** $\frac{6}{7}-\frac{2}{25}$.	**14.** $\frac{25}{31}-\frac{3}{8}$.
5. $\frac{5}{12}-\frac{1}{3}$.	**10.** $\frac{12}{13}-\frac{5}{39}$.	**15.** $\frac{42}{49}-\frac{21}{98}$.

EXERCISE 90.—ORAL

What fraction does x stand for in the following?

1. $\frac{1}{3}+x=\frac{3}{4}$. **2.** $\frac{3}{4}+x=\frac{5}{6}$. **3.** $\frac{1}{3}-x=\frac{1}{6}$.

4. $\frac{2}{3}-x=\frac{1}{4}$.	**7.** $\frac{7}{8}+x=\frac{11}{12}$.	**10.** $x-\frac{1}{3}=\frac{3}{5}$.
5. $\frac{1}{4}+x=\frac{6}{12}$.	**8.** $\frac{3}{4}-x=\frac{1}{16}$.	**11.** $x-\frac{2}{3}=\frac{5}{6}$.
6. $\frac{3}{10}-x=\frac{1}{5}$.	**9.** $1\frac{1}{3}-\frac{2}{3}=x$.	**12.** $3\frac{5}{6}-1\frac{1}{2}=x$.

148. Find the value of $13\frac{1}{5}-9\frac{1}{2}$.

As in addition of fractions, the whole numbers and the fractions may be subtracted separately, but in the above problem we observe that the fraction $\frac{1}{2}$ cannot be subtracted from the fraction $\frac{1}{5}$ of the minuend.

The problem may be restated thus, $12\frac{6}{5}-9\frac{1}{2}$. $12-9=3$. $\frac{6}{5}=\frac{12}{10}$. $\frac{1}{2}=\frac{5}{10}$. $\frac{12}{10}-\frac{5}{10}=\frac{7}{10}$. The remainder, therefore, is 3 and $\frac{7}{10}$, or $3\frac{7}{10}$.

EXERCISE 91. — WRITTEN

Add or subtract as indicated:

1. $2\frac{3}{8}-1\frac{3}{4}$.	**6.** $5\frac{3}{5}+6\frac{4}{7}-3\frac{2}{15}$.
2. $3\frac{1}{4}+1\frac{1}{2}$.	**7.** $525\frac{3}{5}-150\frac{14}{15}$.
3. $9-4\frac{3}{4}$.	**8.** $4\frac{2}{3}+9\frac{7}{8}+10\frac{5}{12}$.
4. $\frac{2}{3}+\frac{3}{4}+\frac{5}{24}$.	**9.** $9\frac{1}{10}+3\frac{4}{15}+2\frac{4}{5}$.
5. $5+6\frac{5}{9}$.	**10.** $4\frac{1}{5}-3$.

EXERCISE 92. — WRITTEN

1. A boy spends $\frac{1}{3}$ of his school days in the common school and $\frac{2}{9}$ in the high school; how much more of his boyhood does he spend in the common school than in the high school?

2. If a boy sleeps $\frac{1}{3}$ of his time and studies $\frac{1}{8}$ of his time, how much time has he left for play?

3. What fraction added to $\frac{1}{2}+\frac{2}{3}$ will make 2?

4. A normal child weighs at birth $7\frac{1}{2}$ lbs., at 1 year $20\frac{1}{2}$ lbs., at 2 years $26\frac{1}{2}$ lbs. What is the difference between its weight at birth and at end of first year? What is the difference between its weight at end of first year and end of second year?

5. At birth a normal child measures in height $20\frac{1}{2}$ ins., at 1 year 29 ins., at 2 years $32\frac{1}{2}$ ins. What is the difference between its height at birth and at end of first year? What is the difference between its height at birth and at end of second year?

6. The organs of the human body are composed of water, as follows: bones $\frac{1}{2}$, muscles $\frac{77}{100}$, brain and spinal cord $\frac{39}{50}$, lungs $\frac{79}{100}$. How much more water is there in muscle than in bone? In brain than in muscle? In lungs than in muscles?

7. The organs of the human body are composed of mineral matter, as follows: bones $\frac{11}{50}$, muscles $\frac{3}{200}$, lungs $\frac{11}{1000}$, brain $\frac{1}{100}$. How much more mineral matter is there in bone than in each of the other organs named?

8. The head of a normal child at 6 years of age measures $20\frac{1}{2}$ ins., at 3 years $19\frac{3}{4}$ ins., at 2 years $19\frac{1}{4}$ ins. Find the difference in measurement between the head of a child 6 years old and that of a child 3 years old; between a 6-year-old child and a 2-year-old child; between a 3-year-old child and a 2-year-old child.

9. The average boy of 8 years is $48\frac{1}{12}$ ins. tall, the average girl of 8 is $48\frac{1}{14}$ ins. What is the difference in their heights?

10. The average girl of 14 weighs $100\frac{8}{25}$ lbs., the average boy $99\frac{14}{50}$. What is the difference?

MULTIPLICATION OF FRACTIONS

EXERCISE 93.—ORAL

1. How much is $\frac{1}{2}$ of 6 inches? $\frac{1}{3}$ of 9 dollars? $\frac{1}{5}$ of 10 cents? $\frac{1}{4}$ of $\frac{8}{9}$?
2. How much is $\frac{1}{2}$ of 12? $\frac{1}{2}$ of $\frac{4}{5}$? $\frac{1}{9}$ of $\frac{18}{19}$?
3. How many inches are there in a foot?
4. How many inches in $\frac{1}{2}$ foot? In $\frac{1}{2}$ of $\frac{1}{2}$ foot?
5. In example 4 the result is what part of a foot?
6. How much is $\frac{1}{2}$ of $\frac{1}{2}$ yard? $\frac{1}{2}$ of $\frac{1}{2}$ dollar?
7. How much is $\frac{1}{5}$ of $\frac{1}{4}$ dollar? $\frac{1}{2}$ of $\frac{1}{10}$ dollar?
8. How much is $\frac{1}{2}$ of $\frac{1}{6}$?

149. Multiplying any number by another number larger than 1 increases its value. When one fraction is multiplied by another, the number of parts as shown by the denominator is increased, but the value of the fraction is decreased, *e.g.*, $2 \times 3 = 6$. $\frac{1}{2} \times \frac{1}{3} = \frac{1}{2}$ of $\frac{1}{3} = \frac{1}{6}$.

150. Multiply $\frac{2}{3}$ by $\frac{3}{9} = \frac{2}{3}$ of $\frac{3}{9}$.

$\frac{1}{3}$ of $\frac{3}{9} = \frac{1}{9}$.
$\frac{2}{3}$ of $\frac{3}{9} = 2 \times \frac{1}{9}$ or $\frac{2}{9}$. Hence, $\frac{2}{3}$ multiplied by $\frac{3}{9} = \frac{2}{9}$.

151. Multiply $\frac{5}{6}$ by $\frac{7}{8} = \frac{5}{6}$ of $\frac{7}{8}$.

$\frac{1}{6}$ of $\frac{7}{8} = \frac{1}{6}$ of $\frac{42}{48} = \frac{7}{48}$.
$\frac{5}{6}$ of $\frac{7}{48} = 5$ times $\frac{7}{48}$, or $\frac{35}{48}$.

152. To multiply a fraction by a fraction, find the

product of the numerators for the **Numerator** and the product of the denominators for the **Denominator.**

EXERCISE 94.—ORAL

Find the product of:

1. $\frac{1}{2} \times \frac{2}{3}$.	**6.** $\frac{3}{4} \times \frac{6}{9}$.	**11.** $\frac{1}{9} \times \frac{2}{5}$.
2. $\frac{1}{3} \times \frac{3}{5}$.	**7.** $\frac{1}{4} \times \frac{8}{15}$.	**12.** $\frac{9}{10} \times \frac{5}{10}$.
3. $\frac{1}{2} \times \frac{6}{11}$.	**8.** $\frac{3}{5} \times \frac{6}{7}$.	**13.** $\frac{3}{5} \times \frac{3}{8}$.
4. $\frac{1}{4} \times \frac{8}{9}$.	**9.** $\frac{4}{5} \times \frac{10}{11}$.	**14.** $\frac{3}{8} \times \frac{9}{8}$.
5. $\frac{2}{3} \times \frac{5}{7}$.	**10.** $\frac{2}{3} \times \frac{6}{7}$.	**15.** $\frac{2}{3} \times \frac{5}{9}$.

153. Instead of multiplying the terms of the fraction together for the product, the process may be indicated, and the factors cancelled.

Multiply $\frac{5}{6}$ by $\frac{4}{5}$.

$$\frac{5}{6} \times \frac{4}{5} = \frac{\cancel{5} \times \overset{2}{\cancel{4}}}{\underset{3}{\cancel{6}} \times \cancel{5}} = \frac{2}{3}.$$

EXERCISE 95.—WRITTEN

By cancellation find the product of:

1. $\frac{4}{9} \times \frac{6}{7}$.	**5.** $\frac{5}{16} \times \frac{12}{25}$.	**9.** $\frac{7}{13} \times \frac{8}{21}$.
2. $\frac{3}{8} \times \frac{7}{15}$.	**6.** $\frac{3}{4} \times \frac{7}{8} \times \frac{9}{10}$.	**10.** $\frac{12}{144} \times \frac{244}{356}$.
3. $\frac{6}{7} \times \frac{13}{45}$.	**7.** $\frac{10}{12} \times \frac{13}{14} \times \frac{7}{8}$.	**11.** $\frac{7}{64} \times \frac{19}{49}$.
4. $\frac{11}{12} \times \frac{21}{48}$.	**8.** $\frac{17}{21} \times \frac{3}{25}$.	**12.** $\frac{6}{8} \times \frac{41}{57}$.

154. Find the product of $\frac{3}{4} \times 14$.

$\frac{3}{4}$ of $14 = \frac{3}{4}$ of $\frac{14}{1} = \frac{42}{4} = \frac{21}{2} = 10\frac{1}{2}$, or by cancellation:

$$\frac{3 \times \overset{7}{\cancel{14}}}{\underset{2}{\cancel{4}} \times 1} = \frac{21}{2} = 10\tfrac{1}{2}.$$

155. To find the product of a fraction and a whole number, regard the whole number as an improper fraction with 1 as its denominator, and multiply the terms together; or indicate the multiplication and cancel the common factors.

EXERCISE 96.—ORAL

Find the product of:

1. $15 \times \frac{1}{3}$.	**7.** $27 \times \frac{2}{3}$.	**13.** $\frac{7}{11}$ of 22.
2. $25 \times \frac{1}{5}$.	**8.** $\frac{3}{5} \times 20$.	**14.** $\frac{6}{7}$ of 12.
3. $10 \times \frac{2}{5}$.	**9.** $\frac{1}{2} \times 16$.	**15.** $18 \times \frac{3}{9}$.
4. $21 \times \frac{2}{3}$.	**10.** $\frac{2}{3} \times 20$.	**16.** $\frac{11}{6} \times 9$.
5. $12 \times \frac{3}{4}$.	**11.** $\frac{5}{6}$ of 30.	**17.** $\frac{4}{9} \times 12$.
6. $16 \times \frac{5}{8}$.	**12.** $\frac{2}{9}$ of 27.	**18.** $\frac{7}{5}$ of 15.

156. Find the product of: 3×2; $3 \times \frac{1}{4}$; $3 \times 2\frac{1}{4}$.

Find the product of $6 \times 3\frac{1}{8} = 6 \times 3 = 18$, $6 \times \frac{1}{8} = \frac{6}{8} = \frac{3}{4}$, $18 + \frac{3}{4} = 18\frac{3}{4}$.

To multiply a mixed number by a whole number, multiply the whole and fractional parts separately, and add the products.

157. Find the product of $2\frac{2}{3} \times 1\frac{1}{5}$.

$$2\frac{2}{3} \times 1\frac{1}{5} = \frac{8}{3} \times \frac{6}{5} = \frac{48}{15} = 3\frac{3}{15}, \text{ or } 3\frac{1}{5}.$$

To multiply a mixed number by a mixed number, reduce each to an improper fraction and multiply the terms.

EXERCISE 97.—WRITTEN

Find the product of:

1. $10 \times 2\frac{19}{25}$.	**3.** $35\frac{1}{2} \times 27$.	**5.** $16\frac{3}{4} \times 12\frac{1}{3}$.
2. $81 \times 62\frac{5}{6}$.	**4.** $33\frac{1}{3} \times 18\frac{1}{2}$.	**6.** $18 \times 33\frac{1}{3}$.

7. $27 \times 42\frac{1}{9}$.	**12.** $81\frac{9}{10} \times 56\frac{1}{3}$.	**17.** $100 \times 6\frac{3}{10}$.
8. $16\frac{3}{4} \times 28\frac{3}{7}$.	**13.** $34 \times 12\frac{1}{2}$.	**18.** $36 \times 4\frac{1}{6}$.
9. $9\frac{2}{3} \times 101\frac{1}{2}$.	**14.** $81 \times \frac{9}{10}$.	**19.** $11\frac{1}{9} \times 11\frac{1}{9}$.
10. $35\frac{7}{8} \times 16$.	**15.** $\frac{15}{16}$ of 512.	**20.** $35 \times 8\frac{6}{7}$.
11. $63\frac{1}{3} \times \frac{1}{3}$.	**16.** $64 \times 8\frac{1}{7}$.	**21.** $100 \times 5\frac{3}{10}$.

EXERCISE 98.—WRITTEN

1. In 1 pint of whole (unskimmed) milk $\frac{87}{100}$ is water, $\frac{1}{25}$ fat, $\frac{7}{200}$ protein, $\frac{1}{20}$ carbohydrates. How much of each food constituent is there in 8 pints or 1 gallon?

2. In 1 pint of buttermilk $\frac{91}{100}$ is water, $\frac{1}{200}$ fat, $\frac{3}{100}$ protein, $\frac{1}{20}$ carbohydrates. How much of each food constituent is there in 8 pints or 1 gallon?

3. In 1 pint of skim milk $\frac{9}{10}$ is water, $\frac{1}{25}$ protein, $\frac{1}{20}$ carbohydrates. How much of each food constituent is there in 1 gallon of skim milk?

4. If a child of 4 to 6 years of age requires daily $1\frac{17}{50}$ grams of protein, $1\frac{1}{2}$ grams of fats, and 5 grams of carbohydrates for each pound of weight, how much of each of these food constituents will be required for a child of 6 years weighing 45 lbs.?

5. How much of each for a child of 4 years weighing 35 lbs.?

6. If a boy of 10 or a girl of 8 years requires daily $1\frac{2}{5}$ grams of protein, $\frac{3}{4}$ gram of fat, and $4\frac{1}{2}$ grams of carbohydrates for each pound of weight, how much of each constituent will be required for a boy of 10, weighing 67 lbs.?

7. How much of each for a girl of 8 years weighing 55 lbs.?

DIVISION OF FRACTIONS

158. How many times is $\frac{1}{4}$ contained in 1? How many times is $\frac{3}{4}$ contained in 1?

Since $\frac{1}{4}$ is contained in 1, or $\frac{4}{4}$, four times, $\frac{2}{4}$ is contained in 1, or $\frac{4}{4}$, $\frac{1}{2}$ of four times, or $\frac{4}{2}$ times.

How many times is $\frac{3}{4}$ contained in 1? $\frac{3}{4}$ is contained in 1, or $\frac{4}{4}$, one-third of 4 times, or $\frac{4}{3}$ times.

How many times is $\frac{1}{4}$ contained in 2?

How many times is $\frac{2}{4}$ contained in 2?

Since $\frac{1}{4}$ is contained in 2, or $\frac{8}{4}$, eight times, $\frac{2}{4}$ is contained in 2, or $\frac{8}{4}$, $\frac{1}{2}$ of 8 times, or $\frac{8}{2}$ times.

How many times is $\frac{3}{4}$ contained in 2? $\frac{3}{4}$ is contained in 2, or $\frac{8}{4}$, $\frac{1}{3}$ of 8 times, or $\frac{8}{3}$ times.

EXERCISE 99. — ORAL

1. How many times is $\frac{1}{5}$ contained in 1? $\frac{2}{5}$ in 1?
2. How many times is $\frac{1}{7}$ contained in 1? $\frac{2}{7}$ in 1? $\frac{3}{7}$ in 1?
3. How many times is $\frac{1}{2}$ contained in 2? $\frac{1}{3}$ in 2? $\frac{3}{4}$ in 2?
4. How many times is $\frac{1}{5}$ contained in 3? $\frac{2}{5}$ in 3?

159. When the product of two numbers is equal to 1, each of the two numbers is called the **Reciprocal** of the other, *e.g.*, $3 \times \frac{1}{3} = 1$. Hence, 3 is the reciprocal of $\frac{1}{3}$, and $\frac{1}{3}$ is the reciprocal of 3. Again, $\frac{7}{5} \times \frac{5}{7} = \frac{35}{35} = 1$. Hence, $\frac{7}{5}$ is the reciprocal of $\frac{5}{7}$, and $\frac{5}{7}$ is the reciprocal of $\frac{7}{5}$.

160. To multiply by the reciprocal of a number is the same as to divide by that number. Hence to divide a whole number by a fraction, or a fraction by a whole number, or a fraction by a fraction, **multiply by its reciprocal.**

161. Divide $\frac{3}{5}$ by $\frac{3}{7}$.

Since, as we have seen, $\frac{1}{7}$ is contained in 1, seven times, $\frac{3}{7}$ is contained in 1, $\frac{1}{3}$ of seven times, or $\frac{7}{3}$ times. If $\frac{3}{7}$ is contained in 1, $\frac{7}{3}$ times, it will be contained in $\frac{3}{5}$, $\frac{7}{3}$ of $\frac{3}{5}$, or $\frac{21}{15}$ or $1\frac{6}{15}$ or $1\frac{2}{5}$ times.

162. Mixed numbers should be reduced to improper fractions before performing the division.

When possible, use cancellation in the process.

EXERCISE 100. — ORAL

Find the quotients of:

1. $16 \div \frac{1}{8}$.	**8.** $\frac{1}{2} \div 8$.	**15.** $\frac{5}{6} \div \frac{3}{4}$.
2. $12 \div \frac{1}{3}$.	**9.** $\frac{9}{10} \div 100$.	**16.** $\frac{8}{12} \div \frac{1}{2}$.
3. $8 \div \frac{2}{9}$.	**10.** $1\frac{3}{4} \div \frac{6}{9}$.	**17.** $\frac{2}{35} \div \frac{1}{7}$.
4. $144 \div \frac{14}{12}$.	**11.** $\frac{3}{5} \div 7$.	**18.** $1\frac{3}{9} \div \frac{1}{8}$.
5. $\frac{1}{5} \div \frac{6}{5}$.	**12.** $21 \div \frac{5}{7}$.	**19.** $8 \div \frac{1}{9}$.
6. $\frac{3}{4} \div \frac{1}{2}$.	**13.** $63 \div \frac{7}{9}$.	**20.** $17 \div 1\frac{1}{2}$.
7. $\frac{2}{3} \div 6$.	**14.** $36 \div \frac{5}{6}$.	**21.** $36 \div \frac{1}{9}$.

EXERCISE 101. — WRITTEN

1. $81 \div \frac{1}{8}$.	**6.** $\frac{3}{17} \div \frac{1}{5}$.	**11.** $4\frac{2}{3} \div 2\frac{1}{6}$.
2. $\frac{20}{27} \div \frac{5}{7}$.	**7.** $2\frac{3}{16} \div 5$.	**12.** $\frac{20}{23} \div 30$.
3. $\frac{24}{29} \div \frac{3}{8}$.	**8.** $2\frac{25}{31} \div 36 \div 6$.	**13.** $\frac{1}{2}$ of $\frac{7}{8} \div \frac{3}{5}$.
4. $144 \div 132$.	**9.** $8 \div \frac{7}{9}$.	**14.** $\frac{2}{3}$ of $\frac{6}{7} \div \frac{1}{9}$.
5. $3.23 \div \frac{1}{7}$.	**10.** $9 \div \frac{5}{7}$.	**15.** $\frac{7}{5} \div \frac{1}{3}$ of $\frac{1}{2} \div \frac{3}{4}$.

16. $3\frac{3}{8}$ of $7\frac{1}{2} \div 6\frac{2}{3}$ of $\frac{7}{8}$.

17. $9 \div \frac{1}{12}$ of $\frac{6}{7} \div \frac{1}{3}$.

18. $240 \div \frac{1}{64} \div \frac{3}{4}$ of $\frac{1}{2}$.

19. $3\frac{3}{8}$ of $1\frac{4}{5} \div \frac{1}{2}$ of $\frac{1}{8}$.

EXERCISE 102. — WRITTEN

1. If a normal child of 7 years weighs $49\frac{1}{2}$ lbs., and a child of 8 years weighs $54\frac{1}{2}$ lbs., what is the average monthly increase in weight?

2. If a child of 7 years has a chest measurement of $23\frac{1}{2}$ ins., and a child of 8 years has a chest measurement of $24\frac{1}{2}$ ins., what is the average monthly growth in chest measurement?

3. If a child of 1 year weighs $20\frac{1}{2}$ lbs., and a child of 10 years weighs $66\frac{1}{2}$ lbs., what is the average yearly increase in weight?

4. A merchant buys a bill of goods: cotton goods \$250.50, silks \$125.75, notions \$75.80. He receives a discount of $\frac{1}{5}$ of the bill for cash. What does he pay for the goods?

5. A man at hard muscular labor requires $1\frac{1}{5}$ times the food of a man at moderate muscular work. If a man at hard work consumes $11\frac{2}{5}$ ounces of roast beef at a meal, how much roast beef is required for a man at moderate work?

6. If a man at moderate work requires $\frac{5}{3}$ the amount of food required for a boy from 10 to 12 years of age, and the food of a man at moderate work for supper consists of 3 ozs. of bread, $\frac{3}{4}$ oz. of butter, 3 ozs. of bananas, and 2 ozs. of cake, how much of these foods is required by a boy of 12 years of age?

7. If the man requires 5 times the amount of food

required by a child of 6 years of age, how much of these foods is required for the 6-year-old child?

COMPOUND AND COMPLEX FRACTIONS

163. An indicated multiplication of a fraction is called a **Compound Fraction,** *e.g.*, $\frac{2}{3}$ of $\frac{6}{7}$ or $\frac{2}{3} \times \frac{6}{7}$ is a compound fraction.

164. An indicated division of a fraction is sometimes called a **Complex Fraction,** *e.g.*, $\dfrac{\frac{2}{3}}{\frac{9}{10}}$ and $\dfrac{\frac{3}{7}}{5}$ are complex fractions, and are read $\frac{2}{3}$ divided by $\frac{9}{10}$ and $\frac{3}{7}$ divided by 5. They are solved as are other examples in division of fractions.

EXERCISE 103. — WRITTEN

Reduce to simple fractions:

1. $\dfrac{\frac{12}{25}}{\frac{7}{5}}$.
2. $\dfrac{\frac{18}{27}}{\frac{5}{9}}$.
3. $\dfrac{\frac{21}{22}}{\frac{9}{11}}$.
4. $\dfrac{\frac{5}{6}}{6}$.
5. $\dfrac{\frac{35}{5}}{12}$.
6. $\dfrac{\frac{45}{9}}{15}$.
7. $\dfrac{\frac{55}{21}}{27}$.
8. $\dfrac{15\frac{1}{8}}{\dfrac{2\frac{1}{5}}{10}}$.
9. $\dfrac{\frac{36}{4} \text{ of } \frac{9}{10}}{\frac{5}{8} \text{ of } 2\frac{1}{2}}$.
10. $\dfrac{\frac{15}{8} \text{ of } \frac{9}{10}}{3\frac{1}{6} \text{ of } 9\frac{1}{2}}$.
11. $\dfrac{\frac{8}{15} \div \frac{11}{12}}{3\frac{1}{3} \text{ of } 6\frac{1}{5}}$.
12. $\dfrac{2\frac{1}{4} \div \frac{9}{10}}{3\frac{1}{3} \div \frac{1}{2}}$.
13. $\dfrac{\frac{8}{17} \text{ of } 11\frac{5}{12}}{\frac{16}{34} \text{ of } 9\frac{2}{16}}$.
14. $\dfrac{11\frac{1}{4} \div 8}{29\frac{1}{6} \div 6}$.

FRACTIONAL RELATIONS OF NUMBERS

165. What part of 6 is 3? What part of 10 is 5? What part of 63 is 9? 9 is $\frac{9}{63}$ of 63, or $\frac{1}{7}$.

To find what part the second of two numbers is of the first, divide the second by the first.

EXERCISE 104.—ORAL

Find what part the second number is of the first:

1. 16, 8.
2. 82, 9.
3. 36, 4.
4. 74, 18.
5. $2\frac{1}{2}$, $1\frac{1}{4}$.
6. 72, $\frac{1}{3}$.
7. $10\frac{1}{2}$, $5\frac{1}{4}$.
8. $1\frac{1}{2}$, $\frac{1}{3}$.
9. $8\frac{4}{9}$, $2\frac{2}{9}$.
10. $6\frac{4}{5}$, $3\frac{2}{5}$.
11. $\frac{3}{4}$, 12.
12. $\frac{5}{10}$, 5.
13. $\frac{4}{9}$, $\frac{1}{9}$.
14. $\frac{6}{7}$, $\frac{7}{6}$.
15. $\frac{7}{8}$, 7.

166. 6 is $\frac{2}{3}$ of what number?

Since 6 is $\frac{2}{3}$ of the number, $\frac{1}{3}$ of the number is $\frac{1}{2}$ of 6, or 3. If 3 is $\frac{1}{3}$ of the number, the number must be 3 times 3, or 9. Hence, 6 is $\frac{2}{3}$ of 9.

167. To find a number when another number and its fractional relation to the unknown number are given, divide the given number by the numerator of the fraction and multiply by the denominator.

EXERCISE 105.—ORAL

1. 99 is $\frac{3}{4}$ of what number?
2. 8 is $\frac{2}{3}$ of what number?
3. 16 is $\frac{3}{4}$ of what number?
4. 15 is $\frac{2}{3}$ of what number?
5. 72 is $\frac{6}{7}$ of what number?
6. 81 is $\frac{9}{10}$ of what number?
7. 16 is $\frac{2}{3}$ of what number?
8. 24 is $\frac{3}{4}$ of what number?
9. 20 is $\frac{5}{6}$ of what number?
10. 21 is $\frac{3}{7}$ of what number?
11. 64 is $\frac{8}{9}$ of what number?
12. 54 is $\frac{6}{7}$ of what number?
13. Tomatoes at $1.75 per dozen cans cost how much per can?
14. Corn at 90 cts. per dozen cans costs how much per can?

15. Dried beef at \$1.80 per dozen cans costs how much per can?

16. A boy has 50 cts. He spends 30 cts. for a book, and 10 cts. for a tablet. What part of his money has he left?

17. A boy's spending money is \$1.60. He spends $\frac{3}{4}$ of it for a fielder's glove. What does the glove cost?

18. If a half-ton of coal costs \$4.50, what will 5 tons cost?

19. If the food required by a man at moderate work is expressed as 100 parts, how many parts are required by the following?

a, man at light work requiring $\frac{9}{10}$ of the food of man at moderate work.

b, woman at moderate work requiring $\frac{4}{5}$ of the food of man at moderate work.

20. How many parts are required by the following?

a, child 6 to 9 years requiring $\frac{1}{2}$ of the food of a man at moderate work.

b, child 2 to 5 years requiring $\frac{2}{5}$ of the food of a man at moderate work.

c, child under 2 years requiring $\frac{3}{10}$ of the food of a man at moderate work.

d, man at hard muscular work requiring $1\frac{1}{5}$ of the food of a man at moderate work.

21. A boy can walk $\frac{1}{2}$ of a mile while an automobile goes 4 miles. How far will the automobile have gone when the boy has walked 5 miles?

22. If four boys can mow the school lawn in $1\frac{1}{2}$ hours, how long will it take one boy? How long will it take two boys?

168. How many cents in $\frac{1}{6}$ of a dollar? $\frac{1}{6}$ of 1 dollar is $16\frac{2}{3}$ cts., therefore, $\frac{1}{6}$ of a dollar multiplied by any number is the same as $16\frac{2}{3}$ cts. multiplied by that number.

169. How many cents in $\frac{1}{8}$ of a dollar? $\frac{1}{8}$ of a dollar is $12\frac{1}{2}$ cts., therefore, $\frac{1}{8}$ of a dollar multiplied by any number is the same as $12\frac{1}{2}$ cts. multiplied by that number.

170. The part of a number which will exactly divide it is called an **Aliquot Part** of that number.

It is often easier to multiply or divide by $\frac{1}{8}$ dollars, $\frac{1}{6}$ dollars, or $\frac{1}{3}$ dollars than to multiply or divide by $12\frac{1}{2}$, $16\frac{2}{3}$, or $33\frac{1}{3}$ cts.

EXERCISE 106.—ORAL

1. What will 18 pineapples cost at $16\frac{2}{3}$ cts. apiece?
2. At $12\frac{1}{2}$ cts. a yard, what will 12 yards of gingham cost?
3. At $33\frac{1}{3}$ cts. apiece, what will 15 blank books cost?
4. At 25 cts. each, what will 16 pairs of stockings cost?

EXERCISE 107.—WRITTEN

1. 40 is what part of 100?
2. 60 is what part of 100?
3. 80 is what part of 100?
4. 75 is what part of 100?
5. $37\frac{1}{2}$ is what part of 100?
6. $31\frac{1}{4}$ is what part of 100?
7. $62\frac{1}{2}$ is what part of 100?
8. $87\frac{1}{2}$ is what part of 100?
9. $66\frac{2}{3}$ is what part of 100?
10. $83\frac{1}{3}$ is what part of 100?
11. $41\frac{2}{3}$ is what part of 100?
12. $58\frac{1}{3}$ is what part of 100?

REDUCTION OF DECIMAL FRACTIONS

171. Express as common fractions and change to lowest terms: .4, .04, .004, .0004.

Express as common fractions and reduce to lowest terms: .25, .025, .0025.

Express as common fractions and reduce to lowest terms: .300, .00003.

172. To reduce a decimal to a common fraction, write the figures of the decimal for the numerator, with 1 and as many ciphers as there are decimal places in the decimal number for the denominator, and reduce this fraction to lowest terms.

EXERCISE 108. — WRITTEN

Reduce to common fractions in lowest terms or to mixed numbers:

1. 0.4.	**6.** 0.7.	**11.** 0.55.	**16.** 1.25.
2. 0.5.	**7.** 0.135.	**12.** 1.05.	**17.** 17.875.
3. 0.115.	**8.** 0.008.	**13.** 5.125.	**18.** 25.135.
4. 0.125.	**9.** 0.375.	**14.** 10.50.	**19.** 2.9375.
5. 0.6.	**10.** 0.10.	**15.** 2.75.	**20.** 7.875.

EXERCISE 109. — ORAL

1. Express as a decimal: $\frac{1}{2}$, $\frac{1}{5}$, $\frac{1}{10}$.

2. Express as a common fraction: 0.2, 0.4, 0.5, 0.1.

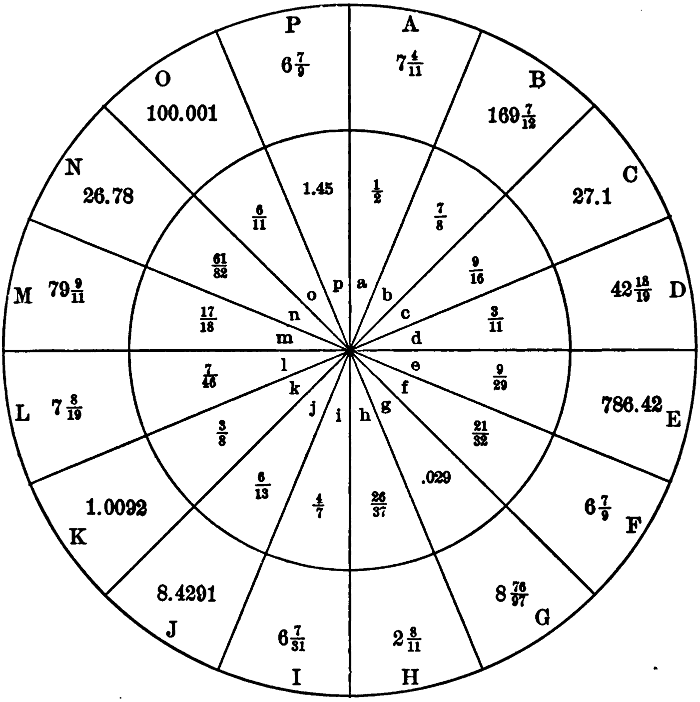
3. Express as decimals: $\frac{1}{4}$, $\frac{2}{5}$, $\frac{3}{4}$, $\frac{1}{8}$, $\frac{3}{8}$, $\frac{4}{5}$.

173. Change $\frac{3}{8}$ to a decimal:

$$\frac{3}{8} = \frac{3.0}{8} = \frac{8)3.000}{0.375}. \qquad \text{Hence, } \frac{3}{8} = 0.375.$$

174. To reduce a common fraction to a decimal, divide the numerator by the denominator, placing the decimal point and annexing as many ciphers as are necessary to complete the division.

175. If the denominator of a common fraction has other prime factors than 2 or 5, the division of the numerator cannot be completed. In such cases it is customary to carry out the decimal to the fifth place and to place a plus sign after the decimal, thus 24.28978 +.



EXERCISE 110. — WRITTEN

1–16. Add the number found in *c* to each number in the outer circle.

17–32. Subtract the number in *b* from each number in the outer circle.

33–48. Subtract the number in *p* from each number in the outer circle in all cases where it is possible.

49–112. Multiply the numbers at *b*, *c*, *g*, *l* by each number in the outer circle.

113–176. Divide each number in the outer circle by the numbers at *b*, *c*, *g*, and *i*.

EXERCISE 111. — WRITTEN

Express as decimals, carrying the division to the fifth place in cases of inexact decimals:

1. $\frac{12}{32}$.	**6.** $\frac{7}{11}$.	**11.** $\frac{19}{20}$.	**16.** $\frac{6}{16}$.
2. $\frac{7}{8}$.	**7.** $\frac{4}{15}$.	**12.** $3\frac{47}{61}$.	**17.** $\frac{2}{11}$.
3. $\frac{5}{9}$.	**8.** $\frac{32}{111}$.	**13.** $37\frac{7}{8}$.	**18.** $\frac{4}{9}$.
4. $\frac{30}{40}$.	**9.** $5\frac{3}{64}$.	**14.** $12\frac{8}{625}$.	**19.** $\frac{12}{13}$.
5. $10\frac{9}{25}$.	**10.** $\frac{17}{18}$.	**15.** $4\frac{21}{44}$.	**20.** $\frac{3}{7}$.

EXERCISE 112. — WRITTEN

REVIEW PROBLEMS

1. 160 is $\frac{2}{3}$ of what number?

2. 144 is $\frac{9}{16}$ of what number?

3. 150 is $\frac{2}{3}$ of what number?

4. 180 is $\frac{3}{4}$ of what number?

5. 364 is $\frac{7}{6}$ of what number?

6. In repairing the waste pipes of a house 4 pieces are needed, — $3\frac{1}{4}$ ft., $9\frac{2}{3}$ ft., $4\frac{1}{9}$ ft., and $17\frac{1}{5}$ ft. long. What is the total number of feet needed?

7. A six-sided chicken yard is $3\frac{7}{8}$ rods on one side, $4\frac{1}{2}$ on another, $5\frac{1}{5}$ on another, $1\frac{1}{12}$ on another, $2\frac{3}{5}$ on the fifth side, and 4 rods on the sixth side. How many rods of fence will be required to enclose it?

8. If an apple tree bears 2678 apples and $\frac{1}{2}$ drop, and $\frac{1}{5}$ of the remaining are wormy, what fraction of the apples originally present is good? How many apples are good? If the trees are sprayed to prevent worms, only about $\frac{1}{10}$ will be wormy. What will the fractional gain from spraying be? How many apples are gained?

9. What is the cost of spraying 197 apple trees for black rot at $3\frac{1}{4}$ cts. a tree for each application, spraying 3 times? Adding $1\frac{1}{5}$ cts. to cover cost of arsenite of lead used to prevent the codling moth, what is the cost?

10. According to the Arkansas Experiment Station, $\frac{1}{4}$ of an acre of peanut pasture produced 312 lbs. of pork, and the same area in corn produced 104 lbs. What fraction of the value of peanuts as a pork producer is possessed by corn?

11. Corn at different stages of growth contains water and dry matter in each ton, as follows:

	Corn per 100 Acres	Water per 100 Acres	Dry Matter per 100 Acres
Fully tasselled	90 tons	82 tons	8 tons
Fully silked	129 tons	113 tons	15 tons
Kernels watery to full milk	163 tons	140 tons	23 tons
Kernels glazed	161 tons	125 tons	36 tons
Ripe	142 tons	102 tons	40 tons

What fraction of the corn is dry matter in each period?

How much greater is the fraction representing dry matter "ripe" than "fully tasselled"?

12. A crib of corn holds 10,976 lbs. of ear corn. How many bushels of shelled corn will it yield if $\frac{7}{9}$ of the ear corn is grain and 56 lbs. of shelled corn make a bushel?

13. If it requires $6\frac{2}{5}$ acres of corn to fill a 93-ton silo, how many acres will it require to fill a 60-ton silo?

14. It is estimated that good roads to a farm increase its value about \$$9\frac{1}{4}$ an acre. What would this amount to on a 67-acre farm?

15. Divide the number 81 into 2 parts such that $\frac{5}{6}$ of the first shall be $\frac{2}{3}$ of the second.

16. A man by working $7\frac{1}{2}$ hrs. a day can complete a piece of work in $11\frac{1}{3}$ days, how many hours must he work per day so that he will complete the work in 15 days?

17. If a boy can do $\frac{2}{3}$ as much as a man, how many days will he require to complete the work in the above problem, working the same number of hours as the man?

CREAMING

18. In skimming cream from shallow pans in the usual way, about $\frac{11}{2500}$ of the skimmed milk is butter fat. Milk before skimming usually contains $\frac{42}{1000}$ butter fat. What fraction of the original butter fat is lost in skimming?

19. If a cow produces 256 lbs. of butter fat in a year, how much is lost in skimming? What is its value at 23 cts. a pound?

20. In setting milk in deep pails and using better skimming methods, the skimmed milk is only $\frac{1}{600}$ butter fat.

What fraction of the original butter fat is lost? How many pounds? What value?

21. When a hand separator is used, skimmed milk is only $\frac{1}{5000}$ butter fat. What fraction of the butter fat is lost? How many pounds? What is its value?

22. What fraction is saved by the separator that is lost by the shallow-pan method? What fraction is thus saved that is lost by deep setting?

23. If a cow in a year gives 6278 lbs. of milk of which $\frac{1}{25}$ is butter fat, and $\frac{1}{5000}$ of this amount be lost in sepa-

rating, and there be an increase of $\frac{1}{6}$ in weight in the amount remaining (due to water, salt, etc., used in making the butter), what will be the butter yield?

24. How many cows will a dairyman need in order to save enough butter in a year, by the use of a separator, to enable him to pay for a \$65 separator? Use the facts given in problems 18, 19, and 21.

25. In one herd the average of butter fat per cow was 285.62 lbs. If this were all converted into butter containing $\frac{4}{5}$ fat, what would be the amount? The best cow in the herd gave 439.37 lbs. of butter fat. How much butter does that equal?

26. Assuming that in problem 23 $\frac{4}{5}$ of the whole milk becomes skimmed milk and that it be $\frac{1}{4000}$ butter fat, and that $\frac{3}{4}$ of the cream becomes buttermilk containing $\frac{1}{200}$ of butter fat, what is the loss in butter fat? What is its equivalent in butter?

27. The cost of feed to produce 100 lbs. of milk in New York was as follows from 19 different cows: \$.62, \$.61, \$.46, \$.55, \$.49, \$.89, \$.82, \$.62, \$1.48, \$.77, \$.70, \$1.07, \$.74, \$.85, \$.75, \$.81, \$.59, \$.53, \$.44. What was the average cost per pound?

28. The cost for each pound of butter fat was \$.115, \$.155, \$.18, \$.225, \$.175, \$.16, \$.13, \$.16, \$.17, \$.14, \$.12, \$.26, \$.125, \$.14, \$.185, \$.21, \$.27, \$.15, \$.225. What was the average cost of butter fat per pound?

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29. If a tree 9 ins. in diameter yields only $\frac{1}{9}$ as much lumber as one 18 ins. in diameter, and the lumber of the smaller tree is worth only $\frac{1}{2}$ as much per foot as that of the larger tree, what is the difference in the value of

two such trees, if the smaller one yields 132 ft. of lumber and it is worth $1\frac{1}{4}$ cts. a foot?

30. If 1 lb. of butter is composed of $\frac{143}{1250}$ water, $\frac{529}{625}$ butter fat, $\frac{51}{5000}$ curd, and the balance salt, how much salt is there in 16 lbs. of butter?

31. A hayseed mixture consists of 3 parts red clover and 7 parts tall oat grass. How many pounds of each are needed for 27 acres, using 35 lbs. to the acre?

32. Another mixture is red top 3 parts, orchard grass 4 parts, meadow fescue 2 parts, and red clover 1 part. Using 40 lbs. to the acre, how many pounds of each kind of seed are needed for 29 acres?

33. A good pasture mixture is Kentucky blue-grass $2\frac{1}{2}$ parts, white clover 1 part, perennial rye 3 parts, red fescue 1 part, red top $2\frac{1}{2}$ parts. Sowing 35 lbs. to the acre, how many pounds of each are needed for 26 acres?

34. If, in a score card for judging butter, $\frac{9}{20}$ of the total points are given for perfect flavor, $\frac{3}{10}$ for grain, $\frac{3}{20}$ for color, and $\frac{1}{10}$ for salting, what will be the numerical value assigned to each in a score card of which the total number of points is 100?

35. A hog when alive weighs 312 lbs. and the dressed carcass weighs $\frac{1}{5}$ less; what is the weight of the dressed carcass?

36. What is the difference in cost of a 2-2-50 (2 lbs. of bluestone, 2 lbs. of lime, 50 gallons of water) and a 6-4-50 Bordeaux mixture with lime at $1\frac{1}{8}$ cts. a pound, bluestone at $6\frac{1}{7}$ cts. a pound? Using 150 gallons to the acre, what is the difference per acre in the cost of these two mixtures?

37. In an Arkansas orchard 6 apple trees sprayed to prevent the bitter rot yielded 8674 sound apples and 989 diseased ones; on 3 unsprayed trees 188 sound apples and 4244 diseased ones. What fraction was sound in each case? Reduce to similar fractions for comparison. How many times greater is the yield of sound apples when sprayed than when not sprayed?

38. Two cows, Glista and Belva, were very similar in outward appearance, age, and weight. Glista required 21 cts. worth of feed to produce 1 lb. of butter fat. Belva produced 1 lb. for $15\frac{1}{2}$ cts. What fraction of the feed required by Glista was sufficient for Belva?

39. Seven samples of clover seed sold per bushel (60 lbs.) for: $5.50, $5.25, $5.00, $4.75, $4.75, $4.00, and $3.50. They contained, respectively: $55\frac{8}{10}$, $45\frac{72}{100}$, $55\frac{2}{10}$, $55\frac{8}{10}$, 48, $52\frac{38}{100}$, and $27\frac{72}{100}$ lbs. of good seed to the bushel. What was the price paid for a bushel of good seed in each case?

40. Concrete is made of cement, sand, and aggregate (coarser material, gravel, crushed stone, etc.) in quantities of 1 part to 2 parts to 4 parts. How many pounds of each material are required for 4000 lbs. of concrete?

41. Another mixture often used is 1 to $2\frac{1}{2}$ to 5. Employing this mixture, how much of each material is needed to make 4000 lbs. of concrete?

42. Using the quantities 1 to 3 to 6, how many pounds of each ingredient are needed to make 4000 lbs. of concrete?

43. If the entire corn plants on an acre weigh 6800 lbs., what is the weight of grain, cobs, stalks, leaves, and shucks, if $\frac{9}{20}$ of the plant be ears, and of these $\frac{4}{5}$ be grain

and $\frac{1}{5}$ cobs; and $\frac{11}{20}$ be stover, and of this $\frac{3}{5}$ is stalk, $\frac{3}{10}$ leaves, and $\frac{1}{10}$ shucks?

44. A 3-penny standard wire nail is $1\frac{1}{4}$ ins. long, a 4-penny nail $1\frac{1}{2}$ ins., a 5-penny nail $1\frac{3}{4}$ ins., a 6-penny nail 2 ins., an 8-penny nail $2\frac{1}{2}$ ins., a 10-penny nail 3 ins., and a 20-penny nail 4 ins. What fraction of an inch increase in length is there for every pennyweight increase between 3 pennyweights and 10 pennyweights?

May 17, 1908.	Mls.	141	13
New York ....lve.	.....	.....	.....
West 23d Street	.....	.....	.....
Liberty Street	.....	.....	.....
Phila. (24th & Chestnut Sts.)..	.....	.....	.....
[LEAVE	.....	A M	.....
Baltimore (Camden Sta.)+.	0	†5 00	.....
Relay ....♂	9.0	5 16	.....
Hanover ....♂	11.5	5 23	.....
Dorsey ....♂	13.8	5 28	.....
Jessup ....♂	15.8	5 32	.....
Annapolis Junc ♂ ...arr.	17.9	5 38	.....
Annapolis+ ....arr.	.....	.....	.....
Annapolis ....lve.	.....	.....	.....
Annapolis Junction.lve.	17.9	5 38	.....
Savage	19.4	5 42	.....
Laurel ....♂	21.3	5 46	.....
Muirkirk ....♂	24.9	5 54	.....
Beltsville..................	27.1	5 58	.....
Branchville	29.9	6 03	.....
Hyattsville	33.4	6 11	.....
Washing- {New Union} ♂ ar.	40.0	6 25	.....
ton { Station } +lv.	40.0	A M	.....
Rockville ....♂	56.5		.....
Gaithersburg.............♂	61.5	.....	.....
Boyd ....♂	69.1	.....	A M
Washington Junc ...♂	82.8	.....	*6.51
Brunswick + ...♂	89.8	.....	†7 10
Weverton ....♂	92.7	.....	7 25
Harper's Ferry+ ....♂	95.6	.....	7 38
Shenandoah Junc+ .♂	103.0	15	7 55
Kerneysville	106.5	A M	8 04
Martinsburg+ ....♂	114.2	†6 30	8 20
North Mountain	121.6	6 44	A M
Cherry Run+	127.6	6 53	.....
Hancock+ ....♂	137.0	7 14	.....
Sir John's Run.......♂	142.6	7 29	.....
Woodmont	147.5	7 40	.....
Orleans Road ....♂	152.9	7 52	.....
Baird ....♂	159.8	8 07	.....
Magnolia ....♂	163.1	8 14	.....
Paw Paw.................♂	168.0	8 25	.....
Okonoko.................♂	172.8	8 36	.....
Green Spring ....♂	178.3	8 48	.....
Patterson Creek ....♂	185.1	9 03	.....
Cumberland+ ....♂	192.2	9 20	.....
[ARRIVE	.....	A M	.....

45. If it is desired to nail a $\frac{7}{8}$-in. board to a $1\frac{1}{2}$-in. board with as long a nail as possible but not allow the nail to come nearer than $\frac{1}{16}$-in. of going through both pieces, how long a nail can be used?

46. In nailing a $\frac{3}{16}$-in. piece to a $\frac{5}{8}$-in. piece, with a 3-penny nail, how much will the nail extend beyond the wood?

47. In nailing a $\frac{7}{8}$-in. piece to a 1-in. piece, with a 5-penny nail, how much will the nail lack of reaching through the wood? In using a 6-penny nail, how much will it project beyond the wood? In each of the

above cases what will be the result if the nail be countersunk $\frac{1}{16}$ in.?

48. The table on page 145 is a reproduction of a Baltimore and Ohio time-table showing the distances between stations in miles.

How far is it from Baltimore to Washington? From Annapolis Junction to Washington? Washington to Harper's Ferry? Harper's Ferry to Cumberland? Martinsburg to Cumberland? Annapolis Junction to Magnolia?

49. What would be the cost for each of these distances at the following rates per mile, which are charged by some railroads: 2 cts., $2\frac{1}{4}$ cts., $2\frac{3}{4}$ cts., and $3\frac{1}{4}$ cts.?

50. If a farm is $\frac{11}{40}$ in corn, $\frac{13}{80}$ in wheat, $\frac{27}{160}$ in clover, $\frac{11}{80}$ in oats, $\frac{9}{40}$ in pasture, and the remaining 5 acres is occupied by houses, other buildings, etc., what is the size of the farm, and how many acres are in each crop?

51. A man left to his son $\frac{1}{3}$ of his estate, to one daughter $\frac{2}{5}$, to the other daughter the remainder, amounting to $3268. What was the value of the estate?

52. Walton caught $\frac{2}{3}$ as many fish as Clara, who caught $\frac{4}{7}$ as many as Vernon, whose catch is 63. How many fish did Walton catch?

53. A horse is worth 7 times the buggy. What part of the value of the horse is $\frac{5}{16}$ the value of the horse and buggy?

54. It is estimated that about $700,000,000 are lost annually in the United States through insect and fungous diseases; $\frac{3}{4}$ of this could be prevented by spraying. What amount could be saved by spraying?

ACCOUNTS AND BILLS

176. A **Debt** is that which one person owes to another.

177. A **Debtor** is a person who owes.

178. A **Credit** is that which is due one person from another.

179. A **Creditor** is the person to whom the debt is due.

180. An **Account** is a record of debits and credits.

181. A **Balance** of an account is the difference between the sums of the debits and credits.

182. A **Bill** describes the goods sold by giving quantity and price.

183. The **Footing** of a bill is the total cost.

184. A **Receipt** acknowledges the payment of a bill.

A bill is receipted by the creditor's writing the words "Received Payment" and his signature.

185. ORDERING GOODS

HENDERSONVILLE, S.C.,
Sept. 10, 1908.

CHISHOLM, WARD & CO.,
Market and Madison Sts.,
New York, N.Y.

DEAR SIRS: Please find enclosed $8.37, for which send me by express the following items:

Catalogue No.	Quantity	Articles Wanted	Price Each
C. S. 40805	1	Wickless 2-burner Kerosene Stove	$3.13
B 3137	1	Utility Washing-machine	2.65
C 6490	1	Eclipse Food Chopper	.70
B 4692	1	Empire Clothes Wringer	1.89

Yours truly,
(Mrs.) James A. Monroe.

186. An itemized bill of the above form is received by Mrs. Monroe with the full amount of the cost of the articles stated and the words, "Received Payment," with the signature of the firm.

EXERCISE 113. — WRITTEN

Raleigh, N.C.
Jan. 7, 1908.

1. J. C. Adams,

Bought of John G. Stroud.

5 lbs. Coffee	@	$.30	$
20 lbs. Sugar	@	$.05\frac{1}{2}$	
3 doz. Eggs	@	.23	
1 lb. Cheese	@	.15	
2 lbs. Butter	@	.28	
			$

Compute the amount of each item, place in a column at the right of the double line, add, and make a receipt.

Mrs. C. J. Adams, wishing to stock her pantry for the first time, orders the supplies mentioned below. Make out each number as a separate order to any firm you wish,

complete it as a bill, and write a receipt indicating its payment.

2. Cereals: 1 bbl. flour $7; 10 lbs. graham flour @ 3 cts.; 10 lbs. corn meal @ 3 cts.; 10 lbs. hominy @ 3½ cts.; 4 pkgs. breakfast foods @ 10 cts.; 1 pkg. corn starch 10 cts.; 10 lbs. rice @ 9 cts.; 2 lbs. macaroni @ 15 cts.; 3 lbs. tapioca @ 7 cts.

3. Sugars: 25 lbs. granulated sugar @ 6 cts.; 5 lbs. cut loaf sugar @ 10 cts.; 2 lbs. pulverized sugar @ 10 cts.; 10 lbs. brown sugar @ 5½ cts.

4. Canned vegetables: corn, 6 cans @ $1.50 a dozen; peas, 6 cans @ $1.50 a dozen; tomatoes, 12 cans @ $1.35 a dozen.

5. Canned fruits: peaches, 6 cans @ $3 a dozen; cherries, 2 cans @ 25 cts.; plums, 2 cans @ 25 cts.

6. Dried fruits: raisins, 2 lbs. @ 15 cts.; currants, 2 lbs. @ 13 cts.; prunes, 5 lbs. @ 15 cts.; evaporated apricots, 2 lbs. @ 19 cts.

7. Dried vegetables: dried black beans, 1 quart, 10 cts.; dried Lima beans, 5 quarts @ 15 cts.; dried white beans, 1 peck, 75 cts.; split peas, 2 quarts @ 10 cts.

8. Canned meats: ham, 2 lbs. @ 30 cts.; tongue, 2 lbs. @ 30 cts.; salmon, 2 cans @ 20 cts.

9. Beverages: coffee, 1 lb., 35 cts.; tea, 1 lb., 75 cts.; cocoa, ½ lb. @ 88 cts.; chocolate, 1 lb., 35 cts.

10. Sundries: 1 gal. vinegar, 25 cts.; 1 gal. New Orleans molasses, 60 cts.; baking soda, 2 lbs. @ 8 cts.; cream of tartar, 1 lb., 50 cts.; baking powder, 1 lb., 54 cts.; salt, 25 lbs., 25 cts.; white pepper, ½ lb. @ 50 cts.

DENOMINATE NUMBERS

187. How many inches are there in 1 foot? Express $2\frac{1}{2}$ feet as feet and inches.

A concrete number which represents one kind of unit is called a **Simple Number**; *e.g.*, $2\frac{1}{2}$ ft. is a simple number.

188. A concrete number which is expressed in different units is called a **Compound Number**, *e.g.*, 2 ft. 6 ins. is a compound number.

189. Concrete numbers denoting units of measure are called **Denominate Numbers**, *e.g.*, $2\frac{1}{2}$ ft. is a denominate number.

190. A denominate number composed of units of one denomination is called a **Simple Denominate Number**, *e.g.*, $2\frac{1}{2}$ ft. is a simple denominate number.

191. A denominate number composed of units of more than one denomination is called a **Compound Denominate Number**, *e.g.*, 2 ft. 6 ins. is a compound denominate number.

192. A unit of measure from which other units are derived is called a **Standard Unit**; *e.g.*, the dollar is a standard unit of money, the pound is a standard unit of weight, the yard is a standard unit of measure of length.

193. The process of changing the unit of a denominate number from one denomination to another without chang-

ing the value is called **Reduction,** *e.g.*, changing 1 yd. to 36 ins.

194. If the change be from a higher to a lower denomination, the process is called **Descending Reduction**; if from a lower to a higher, it is called **Ascending Reduction,** *e.g.*, changing 1 yd. to 36 ins. is descending reduction; changing 24 ins. to 2 ft. is ascending reduction.

195. UNITS OF LENGTH

A line has length only. Measures that are used in measuring lines are called **Linear** measures.

196. TABLE OF LINEAR MEASURES

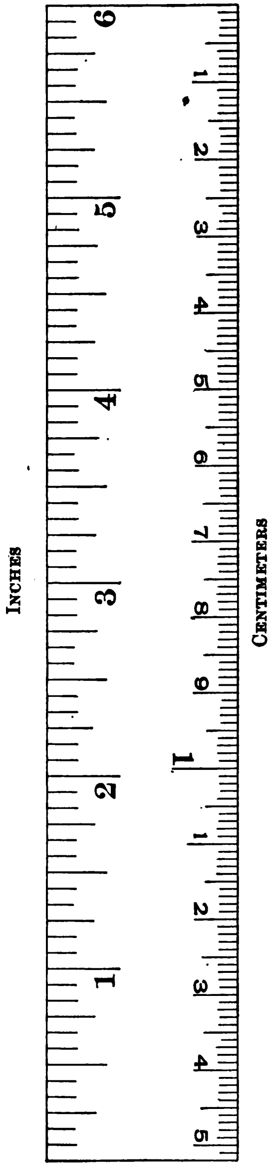
12 inches (ins.) = 1 foot (ft.)
3 feet or 36 ins. = 1 yard (yd.)
$5\frac{1}{2}$ yards, or $16\frac{1}{2}$ ft. = 1 rod (rd.)
320 rods, or 5280 ft. = 1 mile (mi.)

The following abbreviations are also commonly used: ′ to represent feet and ″ to represent inches.

EXERCISE 114.—ORAL

1. How many inches are there in 5 ft.? In 10 ft.?

2. How many feet are there in 3 yds.? In 7 yds.?



3. How many feet are there in 2 rds.? In 4 rds.?

4. How many inches are there in 2 yds.? In 2 ft. 3 ins.?

197. Reduce 12 yds. 2 ft. 8 ins. to inches.

Since 3 ft. = 1 yd., in 12 yds. there are 12 × 3 ft. = 36 ft. 36 ft. + 2 ft. = 38 ft.

Since there are 12 ins. in a foot, in 38 ft. there are 38 × 12 ins. = 456 ins. 456 ins. + 8 ins. = 464 ins. Hence 12 yds. 2 ft. 8 ins. = 464 ins.

198. To reduce a compound denominate number to lower units, multiply the number of the highest denomination by the number of units required to change to the next lower denomination, and to the product add the number of units of this denomination given. Proceed in like manner with this result and each successive result obtained until the number is reduced to the required denomination.

EXERCISE 115. — WRITTEN

Reduce to inches:

1. 2 yds. 2 ft. 6 ins.
2. 4 rds. 2 yds. 1 ft.
3. 25 rds. 12 ft. 4 ins.
4. $\frac{5}{8}$ rds.

Reduce to feet:

5. 2 mis. 15 rds. 6 ft.
6. 3 mis. 30 rds. 15 ft.
7. 25 rds. 10 ft. 4 ins.
8. 3.875 mis.

9. Measure the length, width, and height of your schoolroom, and express as feet, as inches, as yards, as rods, and as fraction of a mile.

EXERCISE 116. — ORAL

1. How many feet in 24 ins.? In 36 ins.? In 18 ins.?
2. How many yards in 30 ft.? In 48 ft.? In 36 ft.?

3. How many rods in 33 yds.? In 66 yds.? In 77 yds.?
4. How many rods in 11 yds.? In 23 yds.? In 99 yds.?

199. Reduce 250 ins. to yards, feet, and inches:

Since 12 ins. equal 1 ft., $\frac{1}{12}$ of 250 ins. $= 20 =$ the number of feet, with 10 ins. remainder. Since 3 ft. $= 1$ yd., $\frac{1}{3}$ of $20 = 6 =$ number of yards, with 2 ft. remainder. Hence, 250 ins. $= 6$ yds. 2 ft. 10 ins.

200. To reduce a denominate number to an equivalent number of higher denomination, divide the given number by the number representing the units of the next higher denomination. Proceed with this and each successive quotient in like manner until the required denomination is reached. The last quotient with the remainders will be the required compound denominate number.

EXERCISE 117. — WRITTEN

1. Reduce 950 ins. to feet.
2. Reduce 496 ins. to feet.
3. Reduce 3966 ins. to yards.
4. Reduce 375 ft. to rods and yards.
5. Reduce 42,560 yds. to rods and miles.
6. Reduce $356\frac{4}{5}$ rds. to miles.

201. METRIC UNITS OF MEASURE

In many foreign countries and to an increasing extent in our own country, another system of measures called the **Metric System** is used. This system is founded upon 10, as are decimal fractions, and is simpler and easier for purposes of computation than are other systems.

202. METRIC LINEAR MEASURES

10 millimeters (mm.) = 1 centimeter (cm.)
10 centimeters (cm.) = 100 mm. = 1 decimeter (dm.)
10 decimeters = 100 cm. = 1000 mm. = 1 meter (m.)
1000 m. = 1 kilometer (km.)

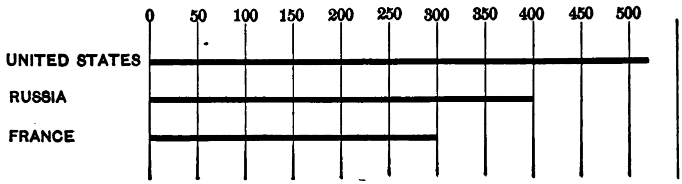
The meter is the unit of measure corresponding to the yard. It is 39.37 ins. long. 1 km. = .62138 mi.

EXERCISE 118. — ORAL

1. What part of a meter is 1 centimeter? 3 cm.?
2. What part of a meter is 1 millimeter? 6 mm.?
3. What part of a meter is 100 millimeters? 500 mm.?
4. Measure the length, width, and height of your schoolroom, and express as meters; as centimeters.

203. REPRESENTATION OF MAGNITUDES

A clear conception of the relative sizes of numbers is often gained by representing the numbers by lines, letting the length of the line bear direct relation to the size of the number, *e.g.*, the approximate amount of wheat produced in 1900 was: United States 520,000,000, Russia 400,000,000, France 300,000,000 bushels. Letting a line $\frac{1}{4}$ in. long represent 50,000,000 bushels, a line $1\frac{1}{2}$ ins. long would represent the yield of France, 2 ins. that of Russia, $2\frac{3}{4}$ ins. that of the United States, thus:



EXERCISE 119. — WRITTEN

1. Represent the coal production of the following countries in metric tons. Let $\frac{1}{4}$ in. equal 25,000,000 metric tons. The production was as follows: The United States 225,000,000, the United Kingdom 225,000,000, Germany 155,000,000, Austria-Hungary 37,500,000, and France a trifle over 25,000,000 metric tons.

2. Represent the silk production of the following countries, letting $\frac{1}{4}$ in. represent 1,000,000 pounds: China 14,000,000, Japan 7,000,000, Italy 7,000,000, Turkey, France, Spain, and India together 3,000,000 lbs.

3. Represent the cotton production, letting $\frac{1}{4}$ in. equal 1,000,000 bales: The United States 10,250,000, India 2,250,000, China 1,250,000, Egypt 1,165,000.

4. Represent the corn production in 1898, $\frac{1}{4}$ in. representing 100,000,000 bushels. The production of the United States was 2,100,000,000; that of other countries about 700,000,000.

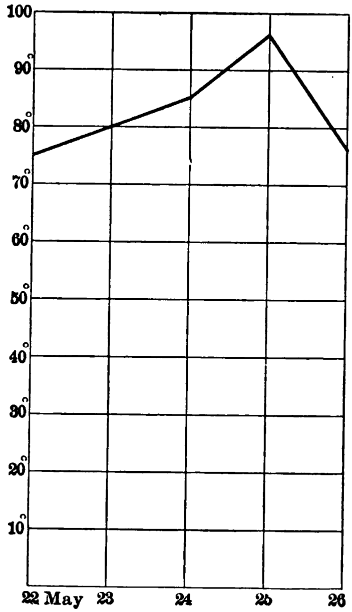


FIG. A

204. Change in a quantity from time to time may be clearly shown by arranging, side by side, the lines repre-

senting the varying magnitudes so that they may be readily compared; thus, the highest temperature for May 22d, at a given place, was 75 degrees, the 23d 80 degrees, the 24th 85 degrees, the 25th 96 degrees, and the 26th 76 degrees. Representing the temperature by vertical lines, 1 degree = 1 mm., at equal distances apart, and connecting the tops of these lines, we have figure A on the preceding page. This is called a **Curve.** The vertical lines are unnecessary, the curve alone being sufficient to picture the facts.

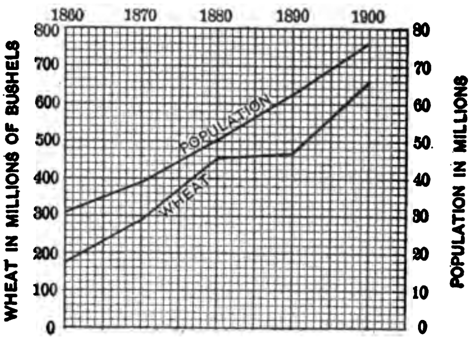


Fig. B. — Curves showing the relative increase in population and in wheat production in the United States, wheat and population both expressed in millions.

EXERCISE 120. — WRITTEN

1. Interpret in words the meaning of the curves shown in the above figure.

2. The maximum price of corn per bushel in Chicago in May during 9 years was as follows: In 1893, 38 cts., in 1894, 55 cts., in 1895, 29 cts., in 1896, 25 cts., in 1897, 37 cts., in 1898, 35 cts., in 1899, 40 cts., in 1900, 58 cts.,

in 1901, 65 cts. Show these values by a curve, letting 2 mm. represent 1 cent. Place the lines representing years 1 cm. apart.

3. The maximum wholesale price of wheat per bushel in Chicago in 1905 was as follows: January $1.21, February $1.24, March $1.19, April $1.18, May $1.14, June $1.20, July $1.20, August $1.15, September $0.95, October $0.92, November $0.92, December $0.90. Show the changes in price by a curve, letting 1 cm. represent 1 cent. Place the lines representing months 1 cm. apart.

SURFACE MEASURE

205. A surface has two dimensions, **Length** and **Width.**

206. If a surface is flat and has four square corners, it is called a **Rectangle.**

207. A rectangle with four equal sides is called a **Square.**

208. The unit of surface is a square. A square inch is a square each side of which is 1 in. long. A square foot is a square each side of which is 1 ft. long. A square yard is a square each side of which is 1 yd. long.

209. The **Area** of a surface is expressed by the number of square units it contains.

EXERCISE 121. — ORAL

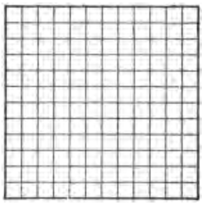
1. A rectangle is 6 ft. long and 1 ft. wide. How many square feet are there in its surface? How many square feet if it is 2 ft. wide? 3 ft. wide? 6 ft. wide?

2. How many square inches are there in a square whose sides are 5 ins.? 6 ins.? 8 ins.? 10 ins.? 12 ins.?

3. How many square centimeters are there in a square whose sides are 6 cm. long? 7 cm.? 9 cm.? 18 cm.?

4. How many square rods in a school lot whose sides are 8 rods? 9 rods? 11 rods? 13 rods?

210. SQUARE MEASURE



144 square inches (sq. ins.) = 1 square foot (sq. ft.)
9 square feet = 1 square yard (sq. yd.)
$30\frac{1}{4}$ square yards = 1 square rod (sq. rd.)
160 square rods = 1 acre (A.)
640 acres = 1 square mile (sq. mi.)

METRIC SQUARE MEASURE

100 square millimeters (sq. mm.) = 1 square centimeter (sq. cm.)
100 square centimeters = 1 square decimeter (sq. dm.)
100 square decimeters = 1 square meter (sq. m.)
10,000 sq. m. = 1 hectare = 2.4711 A.

EXERCISE 122. — WRITTEN

Reduce to square inches:

1. 13 sq. yds. 5 sq. ft.
2. 19 sq. rds. 7 sq. ft.
3. 26 sq. rds. 6 sq. ft.
4. $\frac{5}{9}$ sq. rd.
5. $\frac{4}{5}$ sq. m. to sq. cm.

Reduce to square yards:

6. 130 sq. rds. 12 sq. yds.
7. 2 sq. mis. 80 sq. rds.
8. 8 A. 5 sq. rds. 29 sq. ins.
9. 5.47 A.
10. 86.4 sq. m. to sq. mm.

11. Measure the area of the floor, and each of the four walls of your schoolroom, and express as square feet; as square yards.

EXERCISE 123. — WRITTEN

Reduce to higher denominations:

1. 6740 sq. ins.
2. 984 sq. ins.
3. 540 sq. mm.
4. 22,160 sq. ft.
5. 9678 sq. yds.
6. 6782 sq. cm.
7. 12,346 sq. rds.
8. 39,271 sq. rds.
9. 3240 sq. cm.

SURVEYORS' MEASURES

211. Surveyors in measuring use a **Chain** consisting of 100 links; its length is 4 rds., or 66 ft.

212. TABLE OF SURVEYORS' LINEAR MEASURE

7.92 inches = 1 link (l.)
25 links = 1 rod (rd.)
4 rods = 100 l. = 1 chain (ch.)
80 chains = 1 mile (mi.)

213. TABLE OF SURVEYORS' SQUARE MEASURE

16 square rods = 1 square chain (sq. ch.)
10 square chains = 1 acre (A.)
640 acres = 1 square mile (sq. mi.)
1 square mile = 1 section (sec.)
36 sections = 1 township.

EXERCISE 124. — WRITTEN

1. Reduce 1560 sq. yds. to chains.
2. Reduce 960 sq. chs. to acres.
3. Reduce 67,820 ins. to chains.
4. Reduce $\frac{3}{4}$ mi. to chains.
5. Reduce 60 chs. to feet; to inches.
6. Measure the distance around your school yard. Express in chains; in links; in feet; in rods; in yards. If rectangular, how many square chains does it equal? What fraction of an acre?

MEASURES OF VOLUME

214. A body that has length, width, and thickness is called a **Solid.**

215. If the rectangles forming the faces of a solid are squares, the solid is called a **Cube.**

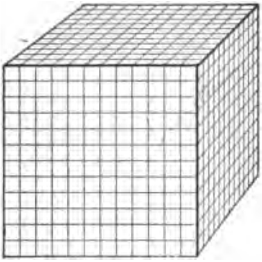
216. The number of solid units that a body contains is called the **Solid Contents** or **Volume.**

EXERCISE 125. — ORAL

1. How many cubic inches are there in a rectangular solid 1 in. long, 1 in. wide, and 1 in. thick?

2. How many cubic feet are there in a solid 1 ft. long, 1 ft. wide, and 1 ft. thick? How many cubic inches? What is the name of such a solid?

3. How many cubic yards are there in a solid 1 yd. long, 1 yd. wide, and 1 yd. thick? How many cubic feet? Name such a solid.



217. UNITS OF VOLUME, OR CUBIC MEASURE

1728 cubic inches (cu. ins.) = 1 cubic foot (cu. ft.)
27 cubic feet = 1 cubic yard (cu. yd.)
$1\frac{1}{4}$ cubic feet = 1 bu. (approximately)

218. METRIC CUBIC MEASURE

1000 cubic millimeters = 1 cubic centimeter (cc.)
1000 cubic centimeters = 1 cubic decimeter (cdm.)
1000 cubic decimeters = 1 cubic meter (cbm.)

EXERCISE 126. — WRITTEN

Reduce to cubic inches:

1. 10 cu. ft. 145 cu. ins.
2. 46 cu. ft. 149 cu. ins.
3. $\frac{7}{8}$ cu. yd.
4. $\frac{5}{6}$ cu. ft.

5. 45 cu. yds. 18 cu. ft.

6. 8 cu. yds. 16 cu. ft. 425 cu. ins.

7. 29 cu. yds. 12 cu. ft. $1\frac{1}{9}$ cu. ins.

8. 15 cu. yds. 1234 cu. ins.

9. 72 cu. yds. 25 cu. ft.

10. 15 cu. yds. 16 cu. ft.

Reduce to cubic centimeters:

11. 15 cbm. 5 cdm. 10 cc.

12. 300 cbm. 150 cdm.

13. 200 cbm. 125 cdm.

14. 275 cbm. 165 cdm. 15 cc.

EXERCISE 127.—WRITTEN

Reduce to units of higher denominations:

1. 12,865 cu. ins.

2. 924 cu. ft.

3. 6573 cu. ins.

4. 4256 cu. ins.

5. 98,764 cu. ins.

6. 325 cu. ft.

7. How many cubic yards in your schoolroom? How many cubic feet? Cubic inches?

8. How many cubic centimeters in your schoolroom? How many cubic meters?

219. DRY MEASURE

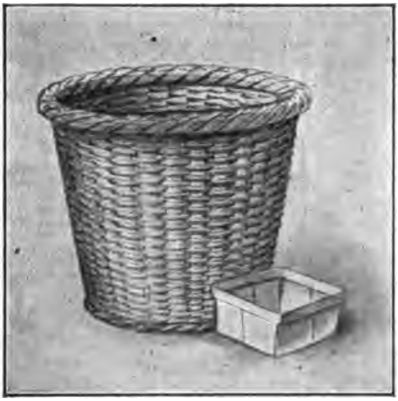
2 pints (pts.) = 1 quart (qt.)
8 quarts = 1 peck (pk.)
4 pecks = 1 bushel (bu.)

A bushel contains 2150.42 cubic inches.

The dry quart contains 67.2 cubic inches.

A **Heaped Bushel**, which equals about $1\frac{1}{4}$ **Stricken Bushels**,

is used in measuring potatoes, apples, and other large vegetables, also for lime, coal, and other bulky substances.



EXERCISE 128. — ORAL

1. How many pints in 5 qts.? In 7 qts.? In 2 pks.? In 1 bu.? In 2 bus.?

2. How many quarts in 3 pks.? In 3 bus.? In 1 bu.? In 12 bus.?

3. How many bushels in 20 pks.? In 25 pks.? In 36 pks.? In 16 qts.?

4. How many pints in 1 bu. 2 qts. 1 pt.?

EXERCISE 129. — WRITTEN

Reduce to pints:

1. 5 bus. 3 pks. 5 qts.
2. 5 bus. 2 pks. 3 qts. $\frac{1}{2}$ pt.
3. .625 pk.

Reduce to higher units:

4. 2254 qts.
5. 3360 pts.
6. 4800 pks.

Reduce the following to fractions of a bushel. Express both as decimals and as common fractions:

7. $\frac{9}{10}$ pt. **8.** $\frac{3}{7}$ qt. **9.** $\frac{3}{4}$ pk. **10.** 2 pks. 8 qts.

11. Get a bushel of sand or grain and a quart measure, and practise estimating quarts, pints, and pecks to see who can make the most accurate estimates at sight.

220. LIQUID MEASURE

4 gills (gis.) = 1 pint (pt.)
2 pints = 1 quart (qt.)
4 quarts = 1 gallon (gal.)

A gallon contains 231 cubic inches.

$31\frac{1}{2}$ gals. are usually considered a barrel, and 2 barrels a hogshead.

221. METRIC LIQUID MEASURE

10 milliliters (ml.) = 1 centiliter (cl.)
10 centiliters = 1 deciliter (dl.)
10 deciliters = 1 liter (l.)

1 milliliter = 1 cubic centimeter. 1 milliliter of water weighs 1 gram.

EXERCISE 130. — ORAL

1. How many gills are there in 6 pts.? In 10 pts.?
2. How many gills are there in 5 qts.? In 8 qts.?
3. How many pints are there in 8 qts.? In 12 qts.?
4. How many quarts are there in 60 pts.? In 45 pts.?
5. How many milliliters are there in 3 l.? How many cubic centimeters in 7 l.?

EXERCISE 131. — WRITTEN

Reduce to units of lower denomination:

1. 12 gals. 2 qts. 1 pt.
2. 25 gals. 1 qt. 1 pt. 2 gis.
3. $\frac{5}{6}$ gal.
4. $\frac{3}{4}$ gal.
5. 14 gals. 2 qts. 1 pt. 1 gi.
6. 45 gals. 2 qts. 1 pt. 3 gis.
7. .225 gal.
8. $\frac{8}{11}$ gal.

Reduce:

9. 12 liters to deciliters.
10. $\frac{3}{10}$ liter to milliliters.

With a pail of water and pint and quart measures, become familiar with all of these units.

EXERCISE 132. — WRITTEN

Reduce to units of higher denomination:

1. 145 pts.
2. 424 gis.
3. 380 pts.
4. 1984 gis.
5. 1286 qts.
6. 1254 pts.
7. $\frac{9}{10}$ deciliter to liter.
8. $\frac{3}{4}$ gi. to fraction of quart.
9. 1 qt. 1 pt. to decimal of gallon.
10. 786 qts. to bbl. and fraction.
11. 6.7 gis. to decimal of gallon.
12. 29 cu. ft. to gallons.
13. 1728 pts. to hogsheads and fraction.
14. $7\frac{3}{4}$ gals. to decimal of barrel.

222. MEASURES OF WEIGHT

Avoirdupois Weight

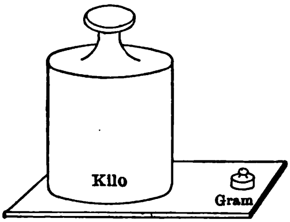
16 drams (drs.) = 1 ounce (oz.)
16 ounces = 1 pound (lb.)
100 pounds = 1 hundredweight (cwt.)
20 hundredweight = 2000 lbs. = 1 ton (T.)
1 avoirdupois pound = 7000 grains.

A cubic foot of water weighs 62.42 pounds.

The ton of 2000 lbs. is sometimes called a **Short Ton**, the **Long Ton** being 2240 lbs. The long ton is used in measuring coal at the mines.

$$\left.\begin{array}{l}\text{500 cu. ft. of hay in loads, or}\\ \text{400 cu. ft. of hay in the mow}\end{array}\right\} = \text{1 ton (approximately)}$$

223. METRIC UNITS OF WEIGHT



10 milligrams (mg.) = 1 centigram (cg.)
10 centigrams = 1 decigram (dg.)
10 decigrams = 1 gram (g.)
1000 grams = 1 kilogram (kilo or k.)

A gram weighs 15.432 grains: it equals the weight of a cubic centimeter of water.

$$1 \text{ pound} = .45^{+} \text{ kilogram.}$$

EXERCISE 133.—ORAL

1. How many ounces are there in 6 lbs.? In 9 lbs.?
2. How many ounces are there in 5 cwts.? In 7 cwts.?
3. How many ounces are there in 6 T.? In 8 cwts.?
4. How many pounds are there in 44 ozs.? In 100 cwts.?
5. How many tons are there in 60 cwts.? In 100 cwts.?

EXERCISE 134.—WRITTEN

Reduce:

1. 3 cwts. 21 lbs. 6 ozs. to ounces.
2. 10 T. 50 cwts. 15 lbs. to pounds.
3. $\frac{5}{8}$ T. to pounds.
4. 5 g. 10 dg. to milligrams.
5. .375 T. to hundredweights.
6. $\frac{9}{16}$ T. to pounds.
7. 17 cwts. 15 lbs. 3 ozs. to ounces.
8. 2 T. 10 cwts. 25 lbs. to pounds.
9. .675 cwt. to pounds.
10. .5 T. to hundredweights.
11. 21 lbs. 6 ozs. to grams.
12. 26 g. to grains.

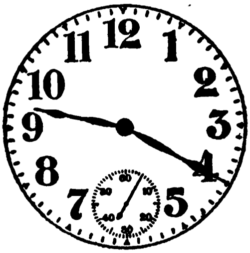
EXERCISE 135.—WRITTEN

Reduce to units of higher denominations:

1. 2500 ozs.
2. 9546 ozs.
3. 1056 mg.
4. 5275 lbs.
5. 4250 ozs.
6. 5420 mg.
7. 15,674 cwts.
8. 2654 grs. to lbs.
9. 5460 grs. to g.

10. Tie up packages of sand or grain of various weights, and practise lifting them until you can judge weight with some accuracy.

224. MEASURES OF TIME



60 seconds (secs.) = 1 minute (min.)
60 minutes = 1 hour (1 hr.)
24 hours = 1 day (da.)
7 days = 1 week (wk.)
12 months (mos.) = 1 year (yr.)

"Thirty days hath September,
April, June, and November,
All the others thirty-one
Except the second month alone,
Which hath but four and twenty-four
Till Leap Year gives it one day more."

The common year has 365 days, or 52 weeks and 1 day. The leap year has 366 days. Years whose numbers are divisible by 4 and not by 100, or by 400, are leap years.

A decade consists of 10 years; a score, 20 years, and a century, 100 years.

EXERCISE 136.—ORAL

1. How many seconds are there in 3 mins.? In 10 mins.? In 15 mins.? In 15 mins. 20 secs.?

2. How many minutes are there in 2 hrs.? In 6 hrs.? In $6\frac{1}{2}$ hrs.? In $8\frac{1}{3}$ hrs.?

3. How many hours in 3 days? In $4\frac{1}{2}$ days? In $5\frac{1}{4}$ days?

4. How many days in 2 wks.? In $5\frac{2}{7}$ wks.? In 5 wks.? In 5 days?

5. How many days in 2 years? In 2 leap years?

EXERCISE 137.—WRITTEN

Reduce to units of lower denomination:

1. 6 hrs. 25 mins. 10 secs.
2. 10 days 5 hrs. 12 mins.
3. $\frac{3}{4}$ day.
4. 867 days.

Reduce to units of higher denomination:

5. 2460 mins.
6. 142.2 hrs.
7. 89,764 secs.
8. $\frac{2}{3}$ hr. to fraction of a day.

9. Practise estimating a second and a minute until you can do so with some accuracy.

ANGLE MEASURE

225. A **Circle** is a plain surface bounded by a curved line, the circumference, every point of which is equally distant from a point within, called the **Centre**.

226. A straight line drawn through the centre of a circle from one point in the circumference to another is called the **Diameter** of the circle.

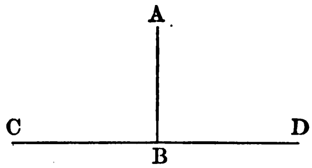
227. A **Section** of the circumference is called an **Arc**.

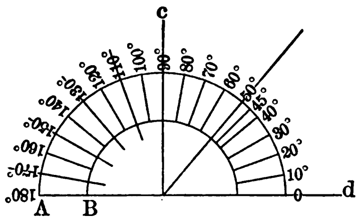
228. The diameter exactly divides the circle.

229. One-half the diameter is the **Radius**.

230. The difference in the direction of two lines that meet is called an **Angle.**

231. A line which cuts another line making with it two equal adjacent angles is said to be **Perpendicular** to the other line, *e.g.*, the line AB is perpendicular to the line CD. The two angles made by the line AB with the line CD are equal. Each of the angles so made is called a **Right Angle,** *e.g.*, the angles ABC and ABD are right angles.





232. The circumference of a circle is measured in **Degrees.** There are 360 degrees in a whole circumference. Degrees are not of uniform length, but vary with the circumference of the circle, *e.g.*, the circumference of the circle A measures 360 degrees as does also the circumference of the circle B. Degrees are divided into minutes and seconds.

233. TABLE OF ANGLE MEASURE

60 seconds ($''$) = 1 minute ($'$)
60 minutes = 1 degree ($°$)
360 degrees = 1 circle.

EXERCISE 138.—ORAL

1. How many degrees are there in a circumference? In a half circumference? In $\frac{1}{4}$ circumference? In $\frac{1}{3}$ circumference?

2. If one line is drawn perpendicular to another, how many degrees are there in each angle so made? How many degrees in the two angles?

3. How many degrees are there in a right angle? What is the difference between a right angle and an angle of 60°? Of 90°? Of 100°? Of 120°?

4. What part of a right angle is 45°? 30°?

5. How many minutes in 6°? 8°? 24°?

6. How many seconds in 3′? 5′? 1°, 6′, 6″?

EXERCISE 139. — WRITTEN

1. Draw an angle of 45 degrees; 90 degrees; 120 degrees; 180 degrees.

2. Reduce 40° 20′ 20″ to seconds.

3. Reduce 43,200″ to degrees. Draw an angle having the number of degrees found.

4. Determine the number of degrees of "pitch" of some roof that is accessible to you.

234. COUNTING

12 things = 1 dozen (doz.)
12 dozen = 1 gross (gr.)
12 gross = 1 great gross (g. gr.)
20 things = 1 score.
24 sheets of paper = 1 quire.

EXERCISE 140. — ORAL

1. A crate contains 492 eggs; how many dozen?

2. A single card contains 24 hooks and eyes. How many gross are there on 48 cards?

3. How many years are three score and ten?

ADDITION AND SUBTRACTION

EXERCISE 141.—ORAL

Add:

1. 12 ft. 1 in.
   13 ft. 9 ins.

2. 7 days 1 hr.
   8 days 12 hrs.

3. 12 lbs. 5 ozs.
   16 lbs. 9 ozs.

4. $120° \; 14' \; 12''$
   $10° \; 15' \; 30''$

5. 20 rds. 4 yds. 1 ft. 0 in.
   10 rds. 1 yds. 0 ft. 6 ins.

235.

16 lbs. 4 ozs.
25 lbs. 3 ozs.
18 lbs. 12 ozs.
59 lbs. 19 ozs., or
60 lbs. and 3 ozs.

Addition and subtraction of compound numbers is performed in the same manner as with simple numbers, the only difference being that units of compound numbers have a varying scale of value, while with simple numbers the scale is uniformly ten.

Add the numbers of each denomination separately, then reduce the sums to the highest units possible.

EXERCISE 142.—WRITTEN

Add:

1. 12 lbs. 12 ozs.
   18 lbs. 10 ozs.

2. 73 rds. 5 ft.
   18 rds. 9 ft.

3. 12 lbs. 8 ozs.
   25 lbs. 6 ozs.

4. 13 bus. 3 pks. 5 qts.
   25 bus. 4 pks. 4 qts.
   9 bus. 1 pk. 1 qt. 1 pt.
   54 bus. 2 pks. 1 qt.

5. 18 gals. 1 qt. 1 pt.
   68 gals. 1 qt.
   25 gals. 3 qts. 1 pt.
   13 gals. 1 qt. 1 pt.

EXERCISE 143.—ORAL

Subtract:

1. 15 ft. 9 ins. 9 ft. 4 ins.	3. 150° 16′ 16″ 100° 8′ 10″
2. 27 T. 12 cwts. 11 lbs. 1 T. 10 cwts. 10 lbs.	4. 3 yds. $3\frac{1}{2}$ ft. 1 yd. 2 ft. 6 ins.

236. Subtract:

45 bus. 3 pks. 1 qt. 0 pt.
39 bus. 1 pk. 0 qt. 1 pt.

In the first right-hand column we have 1 pt. to be subtracted from 0 pt., which is impossible. Taking 1 qt. from the quarts column and changing it to pints gives 2 pts. 1 pt. subtracted from 2 pts. leaves 1 pt. Completing the subtraction the remainder is 6 bus. 2 pks. 1 pt.

Subtract as simple numbers. Increase when necessary the number representing any denomination by taking one unit from the next higher denomination.

EXERCISE 144.—WRITTEN

Subtract:

1. 12 hhds. 10 gals. 3 qts. 10 hhds. 50 gals. 1 qt.	4. 76 mis. $8\frac{3}{4}$ rds. 19 mis. 9 rds.
2. 50 yds. 8 ins. 30 yds. 10 ins.	5. 12 m. 6 dm. 4 cm. 9 m. 9 dm. 8 cm.
3. 25 rds. 3 yds. $1\frac{1}{2}$ ft. 10 rds. 1 yd. 2 ft.	6. 14 l. 8 dl. 5 cl. 5 l. 9 dl. 8 cl.

237. DIFFERENCE BETWEEN TWO DATES

Find the difference between the dates March 6 and July 4:

The number of days in March after the 6th is	25
The number of days in April is	30
The number of days in May is	31
The number of days in June is	30
The number of days in July before the 5th is	4
Total is	120

The difference of dates is 120 days.

To find the difference between two **short** dates, the exact number of days in each month is taken.

238. Find the difference between the dates April 1, 1871 and July 15, 1845:

YRS.	MOS.	DAYS
1871	4	1
1845	7	15
25	8	16

Write the dates as in subtraction of compound numbers, representing the number of years, months, and days in columns.

To find the difference **between two dates of longer period,** that is, covering a period of more than a year, 30 days are considered a month.

EXERCISE 145.—WRITTEN

1. Find the difference of dates between July 4, 1776 and May 20, 1776.

2. Find the difference between April 19, 1774 and October 12, 1492.

MULTIPLICATION

EXERCISE 146.—ORAL

Multiply:

1. 4 ft. 2 ins. by 2.
2. 6 yds. 1 ft. 3 ins. by 2.
3. 12 lbs. 4 ozs. by 3.
4. 49 pks. 2 qts. by 4.

239. Multiply 30 gals. 3 qts. 1 pt. by 6.

30 gals.	3 qts.	1 pt.
		6
185 gals.	1 qt.	0 pt.

6×1 pt. $= 6$ pts., or 3 qts. 6×3 qts. $= 18$ qts. 18 qts. $+ 3$ qts. $= 21$ qts., or 5 gals. and 1 qt. 6×30 gals. $= 180$ gals. 180 gals. $+ 5$ gals. $=$ 185 gals. The product is 185 gals. and 1 qt.

Multiply separately the number representing each denomination. Reduce each product to units of the next higher denomination and add to the product of that denomination.

EXERCISE 147.—WRITTEN

Multiply:

1. 15 bus. 3 pks. 2 qts. by 8.
2. 56 ft. $6\frac{1}{2}$ ins. by 96.
3. 4 T. 25 cwts. 10 lbs. 9 ozs. by 28.
4. 46 mis. 3 ft. by 27.
5. 121 lbs. 4 ozs. by 34.
6. 46 gals. 2 qts. 1 pt. by 12.5.
7. 15 m. 6 dm. 8 cm. by 25.
8. 25 l. 3 dl. by .34.
9. 18 g. 4 dg. 6 cg. by 12.
10. 2 sq. mis. 80 sq. rds. 6 sq. yds. by .245.
11. 3 secs. 50 A. 7 sq. chs. by 364.
12. 15 cu. yds. 19 cu. ft. 108 cu. ins. by 2.75.

DIVISION

EXERCISE 148.—ORAL

Divide:

1. 12 ft. 6 ins. by 2.
2. 35 lbs. 14 ozs. by 7.
3. 54 gals. 3 qts. by 3.
4. 60 ft. by 12 ft.

5. 108 yds. 3 ft. 6 ins. by 9.
6. 54° 20′ 36″ by 6.
7. 25 hrs. 30 mins. 20 secs. by 10.
8. 144 sq. ft. 72 sq. ins. by 9.
9. 48 bus. 2 pks. 3 qts. by 3.
10. 174 yds. by 6 yds.
11. 136 yds. 2 ft. by 5.
12. 154 bus. 3 pks. 2 qts. by 4.

240. Divide 25 gals. 2 qts. 1 pt. by 4.

4)25 gals.	2 qts.	1 pt.	
6 gals.	1 qt.	$1\frac{1}{4}$ pts.	

$\frac{1}{4}$ of 25 gals. = 6 gals. with 1 remainder. 1 gal. = 4 qts. 4 qts. + 2 qts. = 6 qts. $\frac{1}{4}$ of 6 qts. = 1 qt. and 2 qts. remainder. 2 qts. = 4 pts. 1 pt. + 4 pts. = 5 pts. $\frac{1}{4}$ of 5 pts. = $1\frac{1}{4}$ pts.

Divide separately the number representing each denomination. If there is a remainder, reduce it to the next lower denomination and add to the number representing that denomination.

241. Divide 18 lbs. 6 ozs. by 8 lbs. 3 ozs.

18 lbs. = 256 ozs. + 6 ozs. = 262 ozs.
8 lbs. = 128 ozs. + 3 ozs. = 131 ozs.
262 ozs. ÷ 131 ozs. = 2.

In order to divide one compound number by another, both compound numbers must be reduced to simple numbers of the same denomination.

242. Observe that in division of denominate numbers when the divisor and dividend are concrete, the quotient is abstract, *e.g.*, 131 ozs. is contained in 262 ozs. **two times.**

EXERCISE 149. — WRITTEN

Divide:

1. 245 mis. 120 rds. by 8.
2. 945 ft. 6 ins. by 12.
3. 2 lbs. 7 ozs. 14 grs. by 5.
4. 12 yrs. 6 mos. 5 days by 2 yrs. 4 mos. 5 days.
5. 32 gals. 2 qts. by 5 gals. 1 qt. 1 pt.
6. 10 l. 8 dl. 5 cl. by 2 l. 1 dl.
7. 15 m. 8 dm. 6 cm. by 10 m. 2 cm.
8. 25 g. 3 dg. by 12 g.
9. 6984 ins. by 127.
10. 8 A. 25 sq. rds. 3 sq. ft. by 9.5.
11. 1155 sq. rds. 10 sq. ls. by 2.5.

EXERCISE 150. — WRITTEN

	a	*b*	*c*
1	64	23	24
2	72	16	19
3	93	19	16
4	11	78	12
5	2	72	19
6	98	18	78
7	16	21	42
8	18	42	73
9	27	18	64
10	24	7	77

1. If the numbers in line 1 *a*, *b*, *c*, represent respectively tons, hundredweight, and pounds, how many pounds

and how many hundredweight do they equal? How many tons and fraction?

2–10. Solve problems based on lines 2 to 10 as in No. 1.

11–20. If the numbers in columns *a*, *b*, *c* represent respectively miles, rods, and yards, how many yards do the numbers in each line equal? Rods and fraction? Miles and fraction?

21. If the numbers in line 1 *a*, *b*, *c* represent yards, feet, and inches, respectively, how many inches do they equal? Feet and fraction? Yards and fraction?

22–30. Solve each other line as in No. 21.

31. If the numbers in line 1 *a*, *b*, *c* represent bushels, pecks, and quarts, respectively, how many quarts do they equal? Pecks and fraction? Bushels and fraction?

32–40. Solve each other line as in No. 31.

41. If the numbers in line 1 *a*, *b*, *c* represent respectively centuries, years, and days, how many days do they equal? Years and fraction? Centuries and fraction?

42–50. Solve each other line as in No. 41.

51. If the numbers in line 1 *a*, *b*, *c* represent respectively hours, minutes, and seconds, how many seconds do they equal? Minutes and fraction? Hours and fraction?

52–60. Solve each other line as in No. 51.

61. If the numbers in line 1 *a*, *b*, *c* represent respectively barrels, gallons, and quarts, how many quarts do they equal? How many barrels and fraction?

62–70. Solve each other line as in No. 61.

71. If the numbers in line 1 *a*, *b*, *c* represent respectively square miles, acres, and square rods, how many square rods do they equal? Acres and fraction? Square miles and fraction?

72–80. Solve each other line as in No. 71.

81–90. If each number in *a* represents grams, how many pounds does each equal?

91–100. If each number in *a* represents meters, how many inches does each equal? How many yards?

101–110. If each number in *a* represents yards, how many meters does each equal?

111–120. If each number in *a* represents pounds, how many grams does each equal?

EXERCISE 151. — WRITTEN

Review Problems

1. If a man buys 373 lbs. of seed corn at $2 a bushel, and plants 4 qts. to the acre, how many acres can be planted with this seed, and how much will it cost to the acre?

2. A dairyman producing 80 gals. of milk delivers $\frac{1}{2}$ of it in pint bottles, $\frac{1}{4}$ of it in quart bottles. How many bottles of each size are needed for one delivery?

3. Two bushels of peaches are preserved and kept in quart cans. Allowing $\frac{1}{2}$ for shrinkage, how many cans are needed?

4. A barrel of vinegar is sold, half in pints, half in quarts. How many of each are sold?

5. Twenty bushels of garden peas are sold in quart boxes. How many boxes are required?

6. In building a fence 80 rds. long, 4 boards high, with boards 16 ft. long and posts 8 ft. apart, using 2 nails at every point where a board is nailed to a post, how many pounds of tenpenny nails will be needed, allowing 69 nails to the pound?

7. Wind with a velocity of 1 mile an hour (barely observable) exerts a pressure of .005 lb. to the square foot. What is the pressure of such a wind on a tight board fence 1 rd. long, 5 ft. high?

8. With a velocity of 8 miles (a pleasant wind) the pressure is .32 lb. to the square foot. What is the pressure on the fence mentioned in the last problem?

9. With a velocity of 80 mis. an hour (a hurricane) the pressure is 32 lbs. to the square foot. What is the pressure on the fence of problem 7?

10. If each tea bush yields 3 ozs. of tea each year, how many bushes will be required to yield 18 lbs.?

11. If a pound of tea will make 400 cups, how many tea plants will be needed to furnish 1 cup each day for a year for each member of a family of nine?

12. A square piece of land is 81 chs. on a side. What is its perimeter?

13. A city block is 625 ft. on a side. How many chains on one side? How many square chains in a block?

14. How many acres are there in a rectangular enclosure 1 mi. long and $\frac{3}{4}$ mi. wide?

15. A rectangular farm contains 100 A. It is 80 rds. on one side. How long is the other side?

16. Reduce 2482 sq. rds. to square chains.

17. At $960 a mile, what is the cost of making a road 4 mis. and 43 chs. long?

18. At $4.90 a square chain, what is the cost of 27 A. 43 sq. rds. of land?

19. The pressure of the air is 14 lbs. per square inch. What is the air pressure on a table top 38″ × 76″?

20. The longest day in Stockholm is 18 hrs. 30 mins., in London 16 hrs. 32 mins., in Paris 16 hrs., in Boston 15 hrs. 16 mins., in Washington 14 hrs. 52 mins. How much longer is the longest Stockholm day than that of each of the other cities?

21. The shortest day in Stockholm is 5 hrs. 54 mins., London 7 hrs. 44 mins., Paris 8 hrs. 10 mins., Boston 8 hrs. 58 mins. How much shorter is the shortest Stockholm day than that of each of the other cities?

22. How many cubic feet of dirt must be moved in digging a ditch 18″ wide, 2′ 6″ deep, 79 rds. long? How many cubic yards?

23. What will it cost to excavate a cellar 18′ long, 14′ wide and 6′ 3″ deep at $.42 per cubic yard of dirt?

24. How many bushels will a bin hold if it is 5′ wide, 7′ long, 4′ deep?

25. A wagon bed 10′, 8″ long, 3′ wide, and 19″ deep holds how many bushels? How many bushels will it hold with a 6-in. top-box added? How much with a 9-in. top-box?

26. If a bushel of soft coal weighs 80 lbs., how deep must such a wagon bed be to contain 1 ton?

27. How deep a bin 7′ long, 4′ 7″ wide must be built to hold $3\frac{1}{2}$ tons of soft coal?

28. A solid piece of timber 8″ × 9″ × 16′ contains how many cubic feet?

29. A cubic foot of seasoned mahogany weighs 65.1 lbs., of hickory 58.84 lbs., of pitch pine 47.44 lbs., of cedar 42.7 lbs., of hemlock 25.53 lbs., of white pine 21.72 lbs., of ash 39.19 lbs. What is the weight of a piece of each of the above woods of the size mentioned in problem 28?

30. If a cubic foot of soil weighs 87 lbs., what is the weight of the soil of 1 sq. yd., 1 ft. in depth? Of 1 sq. rd., 1 ft. in depth? Of 1 A., 1 ft. in depth?

31. The following table shows the number of pounds of the three important elements of plant food in a ton of four different soils:

	Nitrogen	Phosphoric Acid	Potash
Loam	7 lbs.	3 lbs.	8 lbs.
Clay	3 lbs.	3 lbs.	15 lbs.
Drift	3 lbs.	$\frac{1}{2}$ lb.	6 lbs.
Sand	1 lb.	2 lbs.	5 lbs.

How much of each of these plant foods is there in an acre 1 ft. in depth?

32. In each bushel of the following crops there is the amount of the three chief plant foods indicated by the following table:

Plant Food	Nitrogen	Phosphoric Acid	Potash
Wheat	20 ozs.	8 ozs.	5 ozs.
Rye	17 ozs.	9 ozs.	5 ozs.
Shelled corn	14 ozs.	5 ozs.	3 ozs.
Barley	12 ozs.	6 ozs.	4 ozs.
Oats	10 ozs.	3 ozs.	2 ozs.
Potatoes	3 ozs.	1 oz.	4 ozs.

How many pounds of each of these is taken from the field with 65 bus. of crop?

33. What fraction of an acre is a garden 8 rds. 4 ft. long, 6 rds. 1 yd. wide?

34. How many square feet are there in a floor 15 ft. 3 ins. long by 12 ft. 9 ins. wide?

35. How many square yards are there in a ceiling 27 ft. 4 ins. long, 16 ft. 7 ins. wide?

36. If corn is planted in rows 3 ft. 6 ins. apart and the plants are 13 ins. apart in the row, how many corn plants will there be in a field 30 rds. 3 yds. 2 ft. 9 ins. long by 27 rds. 4 yds. 1 ft. 8 ins. wide?

37. How many square feet are allotted to each plant in problem 36?

38. In 1856 the steamship *Persia* crossed the ocean between Queenstown and New York, a distance of 2800 miles, in 9 days 1 hr. 45 mins. What was the average distance per day?

39. In 1894 the *Lucania* making the same trip crossed in 5 days 7 hrs. 23 mins. What was the average rate per hour? What was the gain in time of crossing over that of the *Persia?*

40. Through how many degrees does the hour hand of a clock pass from 6 A.M. to 3 P.M.? From 12 M. to 3.30 P.M.? From 9 P.M. to 10 P.M.?

41. Through how many degrees does the minute hand pass from 6.15 to 6.30? From 5.45 to 6?

THREAD AND CLOTH

42. A calico cloth 27 ins. wide is made with 64 lengthwise threads (warp) to the inch. How many linear yards of warp are there in a piece of calico $3\frac{1}{4}$ yds. long? In a square yard of calico?

43. Cloth made with 84 crosswise (filling) threads to the inch has how many yards of filling in 3 yds. of cloth 28 ins. wide?

44. A standard wrapping reel is 4 ft. 6 ins. in circumference. How many times will it turn in wrapping 840 yds. of thread?

45. A cloth 30 ins. wide with 80 "ends" (lengthwise threads) to the inch has how many ends?

46. A cloth 30 ins. wide consists of alternate close and open stripes. The close stripes, $\frac{1}{4}$ in. wide, have 60 ends in $\frac{1}{4}$ in. The open stripes have 96 ends in a 1-in. stripe. What is the average number of ends per inch? What is the total number in cloth 28 ins. wide?

47. Cloth made with 84 threads of filling to the inch has how many to the yard?

48. A gentleman's cotton handkerchief $18'' \times 18''$ weighs $\frac{3}{4}$ oz. How many can be made from 450 lbs. of cotton, not allowing for waste?

49. A lady's handkerchief is one-fourth smaller. How many can be made from 450 lbs. of cotton?

50. A bale of cotton weighs 500 lbs. Bagging and ties weigh 25 lbs. This cotton loses $\frac{3}{20}$ during the process of making the warp and filling threads. How many handkerchiefs can be made from the bale if a handkerchief weighs $\frac{3}{4}$ of an ounce?

51. The warp threads in a handkerchief weigh .43 oz. The filling threads in same handkerchief weigh .32 oz. How many pounds of cotton will be used for warp threads and how many pounds for filling threads?

---

52. Wilbur Wright of Ohio is reported to have flown on his aeroplane, in France, on Aug. 8, 1908, a distance of 3 kilometers in 1 min. 46 secs. What was the rate in miles per minute?

53. A man purchases 2520 lbs. of corn and feeds 2 qts. and 1 pt. three times a day to his horse. How long will the corn last? (56 lbs. of corn = 1 bu.)

54. A dairyman produces 50 gals. of milk. Half of this is delivered to customers taking 1 pt. each, $\frac{1}{10}$ to customers taking 2 qts. each, the remainder to customers taking 1 qt. each. How many customers are there?

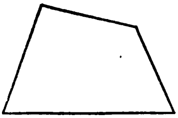
55. A quart of beans weighs 30 ozs. How many pounds are there in a bushel of beans?

56. For a grain bin $6' \times 15\frac{1}{2}' \times 5'$ how much carbon di-sulfide will be required to kill weevils, allowing 1 lb. to every 1000 cu. ft. of space? What will this cost at 29¢ per pound?

MEASUREMENTS

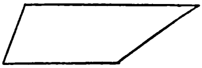
243. A plane figure having four straight sides is called a **Quadrilateral.**

244. A plane figure having four straight sides and its opposite sides parallel is called a **Parallelogram.**



A Quadrilateral

A Parallelogram

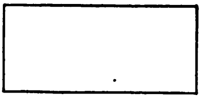


A Trapezoid

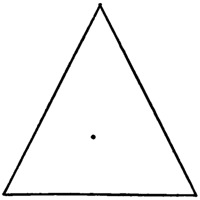
245. A quadrilateral which has only one pair of its opposite sides parallel is called a **Trapezoid.**

246. A parallelogram the angles of which are right angles is called a **Rectangle.**

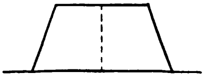
247. A plane figure bounded by three straight lines and having three angles is called a **Triangle.**



A Rectangle



A Triangle

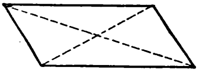


Base and Altitude

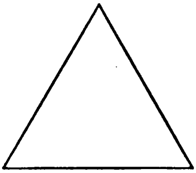
248. The line upon which a figure seems to rest is called the **Base.**

249. The perpendicular distance between the base and the highest opposite point is called the **Altitude.**

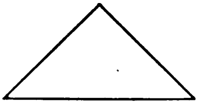
250. The straight lines joining the opposite angles of a parallelogram are called its **Diagonals.**



DIAGONALS



EQUILATERAL TRIANGLE



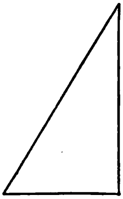
ISOSCELES TRIANGLE

251. **Polygon** is the name given to any figure bounded by straight lines.

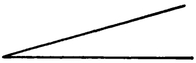
252. The **Perimeter** of a polygon is the distance around it.

253. A triangle whose three sides are equal, is called an **Equilateral Triangle.**

254. A triangle, two of whose sides are equal, is called an **Isosceles Triangle.**



RIGHT TRIANGLE



ACUTE ANGLE

OBTUSE ANGLE

255. A triangle having one right angle is called a **Right Triangle.**

256. An angle less than a right angle is called an **Acute Angle.**

257. An angle greater than a right angle is called an **Obtuse Angle.**

EXERCISE 152.—ORAL

1. What is the perimeter of a square $10\frac{1}{2}$ ft. on a side?

2. What is the perimeter of a rectangle two sides of which are $12\frac{1}{2}$ ft. and $6\frac{1}{4}$ ft. respectively?

3. What is the perimeter of a quadrilateral whose sides are 10, 12, 6, and 8 inches?

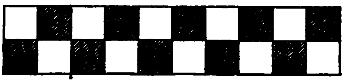
4. What is the perimeter of an equilateral triangle 25 ft. on a side?

5. What is the perimeter of a triangle whose sides are $2\frac{1}{3}$ ft., $3\frac{2}{3}$ ft., and 6 ft.?

6. A triangle has a perimeter of 120 ins.; one side measures 30 ins., another $1\frac{1}{2}$ times this number of inches. What is the length of the third side?

7. The base of an isosceles triangle is 12 ft.; the perimeter is 42 ft. What is the length of each of the equal sides?

EXERCISE 153.—ORAL



1. How many square inches are there in a rectangle 10 ins. long and 1 in. wide? How many rows of square inches are there in the figure?

2. How many rows of square inches are there in a rectangle 10 ins. long and 2 ins. wide? How many square inches are there in a row? In two rows? How many

rows of square inches are there in a rectangle 10 ins. long and 3 ins. wide? How many square inches in a row? In three rows?

3. How many square inches are there in a rectangle 10 ins. long, 5 ins. wide? In a rectangle 10 ins. long, 10 ins. wide?

258. In finding the area or surface of a rectangle, we must think of the surface in rows of square inches, which will give the number of times the square inches in one row is to be taken, *e.g.*, if a square measures 10 ins., there are, as may be seen, 10 rows of square inches of 10 sq. ins. each, or 100 sq. ins.

Hence, the area of a rectangle equals the product of the length by the width.

EXERCISE 154. — ORAL

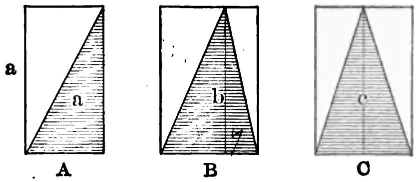
State the areas of the following rectangles:

1. 5 ins. × 10 ins.	**4.** 8 ins. × $8\frac{1}{2}$ ins.	**7.** 7 ins. × 9 ins.
2. 4 ft. × $6\frac{1}{2}$ ft.	**5.** 9 ft. × $6\frac{1}{3}$ ft.	**8.** 4 ft. × 6 ins.
3. 10 ft. × 4 ft.	**6.** 3 m. × $1\frac{1}{5}$ m.	**9.** 1 yd. × 10 ft.

EXERCISE 155. — ORAL

1. What is the relation of triangle *a* to rectangle *A*?

2. What is the relation of triangle *b* to rectangle *B*?



3. What is the relation of triangle *c* to *C*?

From the above, what is true of the area of a triangle?

4. Give the areas of the following triangles: base 4 ins., height 6 ins.; base 9 ins., height 12 ins.; base 3 ft., height 4 ft.; base 3 ft., height 3 ft.

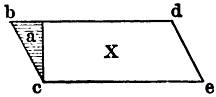
259. The area of a triangle equals $\frac{1}{2}$ the product of the base by the altitude.

EXERCISE 156.—WRITTEN

State the areas of the following triangles:

1. Base 45 ft., altitude 30 ft.
2. Base 16 ft., altitude 12 ft.
3. Base 37 ft., altitude 28 ft.
4. Base 40 ft., altitude 26 ft.
5. Base 67 ft., altitude 55 ft.

260. If you cut off the triangle *a* from the parallelogram *X* and place the line *bc* so that it exactly coincides with *de*, what kind of figure have you? What is true of the area of the first figure as compared with the second?



EXERCISE 157.—ORAL

Give the area of the following parallelograms:

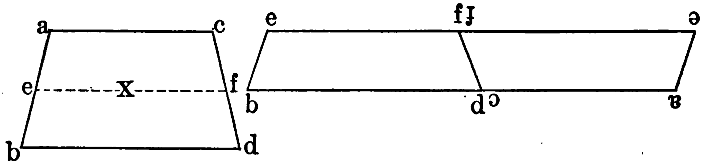
1. Base 12 ins., height 9 ins.
2. Base 14 ins., height 6 ins.
3. Base 18 ins., height 12 ins.
4. Base 15 m., height 6 m.
5. Base 17 ins., height 17 ins.

261. The area of a parallelogram is equal to the product of the base by the height.

EXERCISE 158.—WRITTEN

Find the areas of the following parallelograms:

1. Base 18.4 ins., height 9.2 ins.
2. Base 17¼ ft., height 16.5 ins.
3. Base 34 m., height 20 cm.
4. Base 16 ft. 6 ins., height 12 ft. 4 ins.
5. Base 171.4 ft., height 34.9 ft.
6. Base 3.75 ft., height 4.25 ft.
7. Base 35 m., height 9 cm.
8. Base 345.2 rds., height 6 yds.



262. If you cut the trapezoid X through the line *ef* and place the two sections so that the lines *cf* and *df* coincide, what kind of figure have you?

Is the area of the second figure the same as the area of X? How long is the figure made from the trapezoid? How high is it? To find the area of a trapezoid, what dimensions must be given?

EXERCISE 159.—ORAL

Find the area of the following trapezoids:

1. The parallel sides are 10 ins. and 12 ins., height 6 ins.
2. The parallel sides are 6 ins. and 4 ins., height 4 ins.
3. The parallel sides are 12 ins. and 9 ins., height 8 ins.

4. The parallel sides are 16 ins. and 12 ins., height 9 ins.

263. The area of a trapezoid is equal to the sum of the two parallel sides multiplied by $\frac{1}{2}$ the height.

EXERCISE 160.—WRITTEN

Find the area of the following trapezoids:

1. Parallel sides, 96 rds. and 180 rds., height 108 rds.
2. Parallel sides, 45 rds. and 95 rds., height 64 rds.
3. Parallel sides, 120 ft. and 90 ft., height 40 ft.
4. Parallel sides, 60 m. and 90 m., height 44 m.
5. Parallel sides, 135.5 m. and 34 m., height 110 m.
6. Parallel sides, 62 yds. and 80 yds., height $112\frac{1}{4}$ yds.

264. It has been found that the circumference of a circle is approximately $3\frac{1}{7}$ times the diameter.

Find the circumference of circles with the following diameters:

1. 7 ins.	4. 21 ins.	7. 0.7 m.	10. 45 ft.
2. 14 ins.	5. 77 ins.	8. 14 cm.	11. 84 ft.
3. 49 ins.	6. 0.28 in.	9. 14.7 cm.	12. 105 ft.

265. To find the circumference of a circle, multiply the diameter by $3\frac{1}{7}$, or more accurately by 3.1416.

EXERCISE 161.—WRITTEN

Find accurately the circumferences of the following circles; also find their approximate circumferences. Note the difference in results by the two methods.

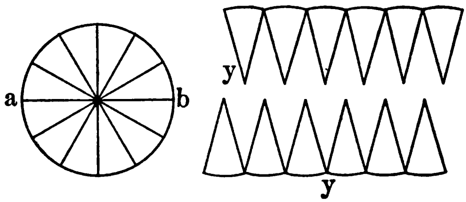
1. Diameter 16 ft.
2. Diameter 21 ft.
3. Diameter 19 ft.
4. Radius 9 ft.
5. Radius 12 m.
6. Radius 45 rds.

EXERCISE 162. — WRITTEN

Find the diameters of circles having the following circumferences:

1. 426 ft.	4. 1400 rds.	7. 318 m.
2. 218 ft.	5. 1676 yds.	8. 164 m.
3. 670 ft.	6. 115.6 rds.	9. 92.45 ins.

266. If you divide the circle shown in the figure by cutting the line *ab*, then cutting each half circle into many small triangles by cutting along each radius, it will be seen that the many triangles joined, as is



suggested in figure *y*, will approximate in area a parallelogram with a length equal to one-half the circumference of the circle and a height equal to the radius of the circle.

The area of a circle is found by multiplying one-half the circumference by the radius, or by multiplying the square of the radius by 3.1416.

EXERCISE 163. — WRITTEN

Find the areas of circles with a:

1. Circumference of 242 ft.	7. Diameter of 77 ft.
2. Circumference of 110 ins.	8. Diameter of 35 m.
3. Circumference of 154 ft.	9. Diameter of 49 rds.
4. Circumference of 96 yds.	10. Diameter of 146 ft.
5. Circumference of 3.75 ft.	11. Diameter of $\frac{7}{8}$ ft.
6. Circumference of 18 yds.	12. Diameter of 54 rds.

EXERCISE 164. — WRITTEN

Find the areas of circles having a radius of:

1. 8 ins. **3.** 4 ft. **5.** 9 m. **7.** 4 rds.

2. 10 ins. **4.** 16 ft. **6.** 8 m. **8.** 5 rds.

SOLIDS

267. A solid has three dimensions, — **Width, Length, and Thickness.**

268. A solid that has six rectangular sides or faces is called a **Rectangular Solid.**

269. A solid that has six square faces is called a **Cube.**

270. A cubic inch is a solid, the faces of which are each one inch square. What is a cubic foot? What is a cubic yard?

EXERCISE 165. — ORAL

1. In a solid 12 ins. long, 1 in. wide, and 1 in. thick, how many rows of cubic inches are there? How many cubic inches are there?


Figure 1

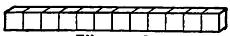


Figure 2

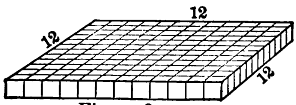


Figure 3

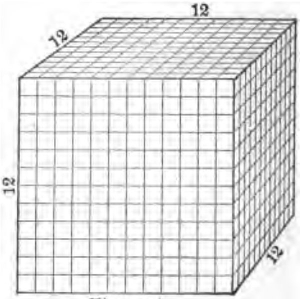


Figure 4

2. In a solid 12 ins. long, 2 ins. wide, 2 ins. thick, how many layers of cubic inches are there? How many rows

of cubic inches are there in one layer? How many cubic inches are there in one layer? How many cubic inches are there in 2 layers?

3. In a solid 12 ins. long, 12 ins. wide, 2 ins. thick, how many layers are there? How many rows are there in one layer? How many cubic inches are there in one row? How many cubic inches are there in one layer? How many cubic inches are there in two layers?

4. In a solid 12 ins. long, 12 ins. wide, 12 ins. thick, how many layers are there? How many rows are there in a layer? How many cubic inches are there in one row? How many cubic inches are there in a layer? How many cubic inches are there in 12 layers?

5. In a solid 4 ins. long, 4 ins. wide, and 4 ins. thick, how many cubic inches are there in the length of the solid? How many rows of cubic inches in the width? How many cubic inches in each layer? How many layers in the solid? How many cubic inches in the solid?

In examples 6, 7, 8, answer all the questions made in example 5.

6. In a solid 4 ins. by 5 ins. by 6 ins.?

7. In a solid 2 ins. by 3 ins. by 12 ins.?

8. In a solid 6 ins. by 8 ins. by 10 ins.?

271. To find the volume of a cube, we must think of it as a solid having a length equal to the number of units in its length and a width equal to that of the rows of cubic units in its width, and a thickness equal to the number of layers of cubic units in its thickness.

272. The volume of a rectangular solid equals the product of the three dimensions similarly expressed.

EXERCISE 166.—WRITTEN

1. How many cubic inches are there in a box 16 ins. long, 8 ins. wide, and 9 ins. deep?

2. How many cubic feet of masonry are there in a wall 120 ft. long, 2 ft. wide, and 4 ft. high?

3. How many gallons of water will a tank $5\frac{1}{2}$ ft. long, $4\frac{1}{8}$ ft. wide, and $2\frac{1}{4}$ ft. deep contain?

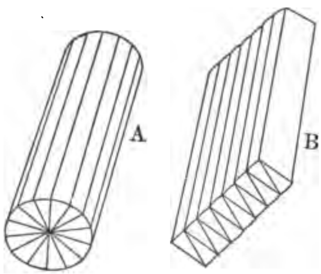
4. How many cubic yards of soil will be excavated in making a ditch 12 ft. long, 2 ft. wide, and 3 ft. deep?

5. How many liters of air are there in a room $13\frac{1}{2}$ m. long, $9\frac{1}{8}$ m. wide, and 3 m. high?

6. The box of a one-horse express wagon is $7' \, 2''$ by $3' \, 2\frac{1}{4}''$ by $8''$. Find the capacity.

7. A two-horse farm wagon is $11' \, 6'' \times 3' \times 10\frac{1}{2}''$. Find the capacity.

THE CYLINDER



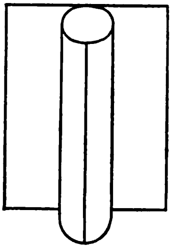
273. A cylinder is a solid having for its ends two equal circles joined by a uniformly curved surface, called its **lateral surface.**

274. A cylinder may be seen in the form of a rectangular solid with a length equal to the length of the cylinder, a width equal to one-half

the circumference of the circular base, a thickness equal to the radius of the circular base.

275. Hence, to find the volume of a cylinder, multiply the number of square units in the base by the height.

276. The lateral surface of a cylinder may be seen in the form of a rectangle, with a length equal to the circumference of the circular base and a width equal to the height of the cylinder.



277. Hence, to find the area of the lateral surface of a cylinder, multiply the length of the circumference of the circular base by the height of the cylinder.

EXERCISE 167. — WRITTEN

Find the volume of the following cylinders:

1. Area of base 126 sq. ins., height $16\frac{2}{3}$ ins.
2. Area of base 72 sq. ins., height 44.56 ins.
3. Area of base 81 sq. ins., height $16\frac{5}{6}$ ins.
4. Area of base 84 sq. ins., height $42\frac{2}{7}$ ins.

EXERCISE 168. — WRITTEN

Find the ~~lateral~~ surfaces of the following cylinders:

1. Circumference of base 40 ins., height 45 ins.
2. Circumference of base 24 ins., height 25 ins.
3. Circumference of base $66\frac{2}{3}$ ins., height 27 ins.
4. Circumference of base $14\frac{2}{7}$ ins. height $64\frac{1}{2}$ ins.

PRACTICAL MEASUREMENTS

PLASTERING, PAINTING, PAVING

278. In estimating labor of lathing, plastering, painting, and paving, the square yard is taken as the unit. In making estimates for plastering, one-half the areas of doors, windows, and other openings is deducted from the total area, and the result expressed to the nearest square yard.

EXERCISE 169. — ORAL

1. What is the perimeter of a room 12 ft. × 14 ft.?

2. If the room is 8 ft. high, what is the area of the 4 walls, making no allowance for the openings in them?

3. What is the area of the ceiling?

4. What will be the cost of plastering this room at 25 cts. a square yard?

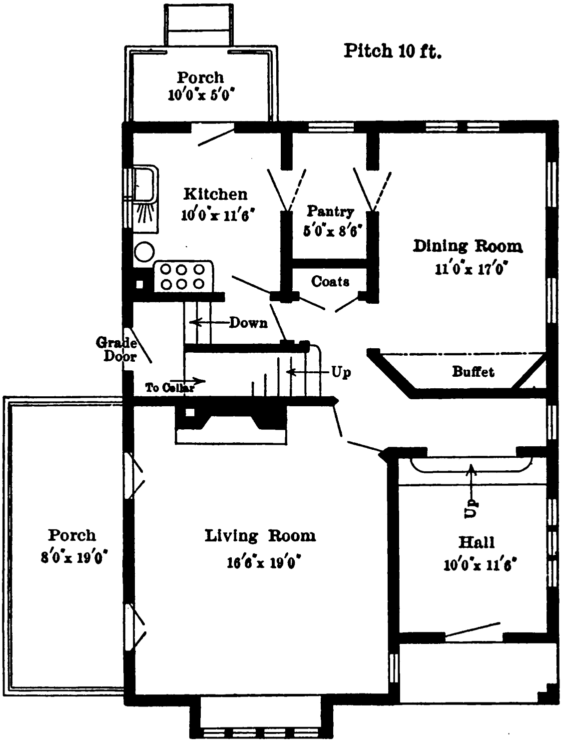
EXERCISE 170. — WRITTEN

In this exercise exclude closets, and make no allowances for windows or doors.

1. To plaster 100 sq. yds. of surface requires 1 barrel of lime, 3 barrels of sand, and 1 bushel of hair. Find the amount of these materials required to plaster each bedroom of the house shown in the two accompanying diagrams, also living room, dining room, and kitchen.

2. What will it cost to lath and plaster the living room, kitchen, and dining room of the lower floor with pulp plaster at a cost of 60 cts. a square yard?

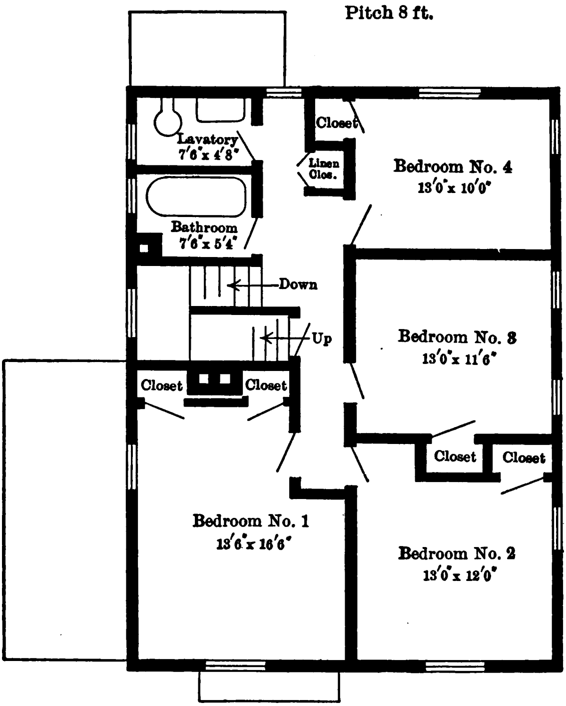
3. To lath and plaster the 4 bedrooms of the upper floor with ordinary plastering will cost 25 cts. a square yard. Estimate the cost.



4. Estimate the number of gallons of paint required to give two outside coats to a house 32 ft. long, 32 ft. wide, 18 ft. high, the gable ends of the roof forming 700 sq. ft. of surface. One gallon of paint covers 300 sq. ft. of surface, 2 coats.

5. At $1.25 a gallon, what would be the cost of painting this house?

6. It requires 1.16 barrels of cement, 0.44 cu. yd. of sand, 0.88 cu. yd. of gravel to make a cubic yard of con-



crete. How much cement will it require to concrete the basement floor of a house, 21 ft. × 18 ft., to a depth of 3 ins.?

7. If 1 cubic yard of concrete costs $3.31, what will be the cost of material in the last problem?

CARPETING

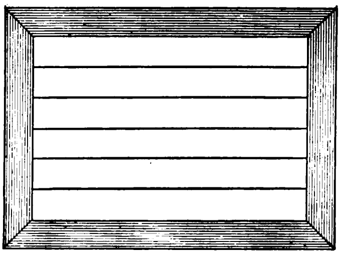
279. Carpets are usually 1 yd. or $\frac{3}{4}$ yd. wide. Brussels and velvet carpeting is $\frac{3}{4}$ yd. wide and is usually sold with a border varying from 22 to 27 ins. in width. Ingrain carpets are 1 yd. wide. Matting is usually 1 yd. wide. Linoleum and oil-cloth are sold by the square yard. The short loops of wool seen in Brussels carpet are made by the use of wires over which the wool is thrown in weaving. The number of wires (usually between 5 and 10 to the inch) used in weaving varies with the price of the carpet and the fineness of the wool.

EXERCISE 171.—ORAL

1. How many loops of wool are there in a piece of 5-wire Brussels carpet $\frac{3}{4}$ yd. wide and 5 ins. long?

2. How many loops of wool in an 8-wire Brussels carpet $\frac{3}{4}$ yd. wide and 5 ins. long?

280. In determining the number of yards of carpet required for a floor, the number of strips should be found, the fractional part of a strip being regarded as a full strip. Often it is necessary to allow for matching and shrinking; 3 inches are also allowed on each end of each strip for turning in. Borders are fitted at each corner, hence the perimeter of the room indicates the length of border required; see figure.



If a floor is 12 ft. wide and the carpet $\frac{3}{4}$ yd. wide, it will require $5\frac{1}{3}$ strips. Since $\frac{1}{3}$ strip cannot be bought, 6 strips must be bought. If the room is 18 ft. long, it will require 6 strips 18 ft. long, or 36 yds. If 9 ins. must be allowed for matching the figure, 9 ins. must be added to each strip, excepting one, since it is not necessary to allow for matching the first strip. Three inches additional must be allowed for turning under. If a 22-in. border is used, only $3\frac{19}{27}$ strips of carpet are actually used, but 4 strips must be bought.

EXERCISE 172. — ORAL

1. How many strips of $\frac{3}{4}$ yd. carpeting are required to carpet a room $12\frac{1}{2}$ ft. wide?

2. The room is 14 ft. long. How many yards, without border, are required, allowing 12 ins. for matching?

3. A room is 12 ft. $\times$ 18 ft. How many strips of $\frac{3}{4}$ yd. carpeting are required?

4. How many yards allowing $\frac{1}{4}$ yd. for matching?

EXERCISE 173. — WRITTEN

Find how many yards of carpet are needed for the following rooms:

1. 15 ft. $\times$ 18 ft. 6 ins.: use 27-in. carpet, allow 9 ins. for matching and use border $\frac{5}{8}$ yd. wide.

2. $16' \times 18'$: use carpet 1 yd. wide, and allow $\frac{1}{2}$ yd. for matching, turning in, and shrinkage.

3. The living room and hall of the house shown by diagram on page 199: use a 10-wire body Brussels carpet $\frac{3}{4}$ yd. wide, with $22\frac{1}{2}$-ins. border, which requires 9 ins. for matching and turning in, and costs \$1.50 a yard, with 10 cts. a yard extra for making.

4. The dining room is covered with an Axminster rug, $8\frac{1}{4}$ ft. $\times$ $10\frac{1}{2}$ ft. at $1 a square yard. What is the price of the rug? How much floor space is left at each side of the rug when the rug is laid in the centre of the room?

5. What will it cost to stain the floor around the rug if 1 qt. of stain is sufficient for 125 sq. ft., the stain costing 50 cts. a quart?

6. The kitchen floor is covered with linoleum which comes only in 2-yd. and 4-yd. widths at $1 a square yard. What is its cost?

7. The bedrooms are carpeted as follows: No. 1 with plain ingrain carpet 1 yd. wide, strips lengthwise. Allowing 6 ins. on each width for turning in and 3 ins. on each width for shrinkage after it is cut, what is the cost at 63 cts. a yard, allowing 3 cts. per yard additional for making?

8. Bedroom No. 2 with China matting 1 yd. wide at 34 cts. a yard, strips lengthwise?

9. Bedroom No. 3 with Japanese matting 1 yd. wide at 21 cts. a yard?

10. Bedroom No. 4 with Sanitas washable carpet 36 ins. wide at 25 cts. a yard, strips lengthwise?

PAPERING

281. Wall paper is usually 18 ins. wide and is sold by the roll. A single roll is 8 yds. long, a double roll 16 yds. Borders are from 3 ins. upward in width.

Deduction is not made for borders, since no allowance is made for matching. Some paper-hangers measure the surface above the base-board, and deduct for windows

and doors, allowing $\frac{1}{2}$ roll for each door or window. It is also customary to find the number of square feet in the walls and ceiling, deduct for doors and windows, and divide by 70, to find the number of double rolls required.

EXERCISE 174.—ORAL

1. How many square feet of wall paper are there in a single roll?

2. How many square feet of wall paper are there in a double roll?

3. If a room measures 12 ft. × 12 ft. and 9 ft. high, how many single rolls of wall paper will be required, making no allowances?

4. How many double rolls are required for the same room?

5. Allowing for 2 windows 6 ft. × 3 ft. and a door $7\frac{1}{2} \times 4$ ft., how many square feet are there left to be papered?

6. How many single rolls are required after making this deduction, making no allowance for matching?

7. How many double rolls?

EXERCISE 175.—WRITTEN

1. How many rolls of paper will be required to paper the living room of the house shown in the diagram on page 199, the base-board 9″ wide, there being 3 windows 3′ × 6′, 1 window 6′ × 6′, one fireplace 7′ × 6′, and 1 door 7′ × 4′, alcove not papered?

   a. Estimate accurately by the number of square feet.

   b. Estimate, allowing $\frac{1}{2}$ roll for each opening.

c. Estimate by dividing total number of square feet by 70, after deducting for the doors and windows.

2. How much will the paper cost at 50 cts. a double roll? (Use answer *c* above.) How much will it cost to paper the ceiling at 20 cts. a double roll? What will picture moulding cost at $3\frac{1}{2}$ cts. a foot, no allowance for openings?

3. The dining room has 2 windows 6 ft. × 3 ft., one, 6 ft. × 6 ft., one opening 6 ft. × 7 ft., and two doors 7 ft. × 4 ft., buffet not papered. If the wall paper costs 30 cts. a double roll and the ceiling paper, 20 cts. a double roll, with no border, but with picture moulding at $2\frac{1}{2}$ cts. a foot, how much is the total cost?

Each bedroom has 2 windows 6 ft. × 3 ft. and 1 door 7 ft. × 3 ft., ceilings and closets not papered.

4. Find the cost of bedroom No. 3 with paper at 25 cts. a double roll, picture moulding $1\frac{1}{2}$ cts. a foot.

5. Find the cost of papering room No. 4 with sanitary wall paper at 30 cts. a double roll, 4-in. border at 2 cts. a yard, ceiling papered at the same price.

282. MASONRY AND BRICKWORK

Brickwork is usually estimated by the **thousand brick.** The unit of measure for walls built of stone is the **perch.**

Twenty-two bricks of common size laid in mortar are reckoned for each cubic foot of wall. Common brick measure 8 × 2 × 4 ins. The mortar occupies $\frac{1}{4}$ in. in thickness between bricks. A **perch** measures $16\frac{1}{2}' \times 1\frac{1}{2}' \times 1'$ and equals $24\frac{3}{4}$ cubic feet. In practice a perch is understood to be 25 cubic feet.

It requires for each square foot of wall:

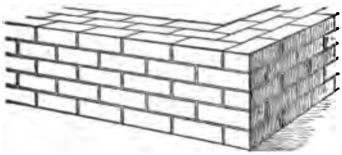
7 bricks, if the wall is 1 brick in thickness.
15 bricks, if the wall is 2 bricks in thickness.
22 bricks, if the wall is 3 bricks in thickness.

In estimating **work**, deductions are not usually made for openings of less than 100 sq. ft. area. In estimating **materials**, deduct for openings.

EXERCISE 176.—ORAL

1. How many bricks are required for a wall 10 ft. long, 5 ft. high, 1 brick thick? 2 bricks thick? 3 bricks thick?

2. How many bricks are required for a wall 1 brick thick, for a cellar 10 ft. × 12 ft., not allowing for openings? 2 bricks thick? 3 bricks thick?



3. How many perch of stone are required for a wall 50 ft. long, 10 ft. high, 1 ft. 4 ins. thick?

To find the number of bricks required for a wall, multiply the number of square feet by 7, 15, 22, or 29 according as the wall is 1, 2, 3, or 4 bricks thick.

EXERCISE 177.—WRITTEN

1. If a cellar is 18′ × 24′ × 9′, inside dimensions, how many bricks are used in walling it 2 bricks thick?

2. How many perches of stone are required for the walls of a cellar 18′ × 24′ × 9′, 6″, the wall 18″ thick?

3. Find cost of construction in problems 1 and 2 with bricks at $8.50 per M and labor $3.00 per M, allowing no deductions for openings, stone costing $18.00 per perch and $1.50 per perch for labor.

4. How many bricks will be required to wall a house 36′ long, 30′ wide outside, and 34′ high, including the cellar, the wall to be 2 bricks thick? No allowance for openings.

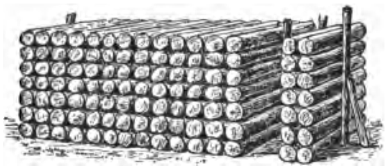
5. The cellar and rear walls of the house of problem 4 are of common brick, the cellar dimensions being 36′ × 30′, 6″ × 9′, the openings 1 door 6′ × 3′, 2 windows 3′ × $1\frac{1}{2}$′, 2 windows 6′ × 3′. What is the cost of the brick at $8.45 per M? Of the labor at $3 per M?

283. WOOD MEASURE

A cord of wood is 8 ft. long, 4 ft. wide, and 4 ft. high.
128 cu. ft. = 1 cord. 16 cu. ft. = 1 cord foot.

EXERCISE 178.—ORAL

1. A pile of wood is 8 ft. long, 4 ft. wide, 2 ft. high. What part of a cord is it?



2. A pile of wood is 96 ft. long, 4 ft. wide, 4 ft. high. How many cords are there?

3. Another pile is 12 ft. long, 4 ft. wide, 4 ft. high. How much wood is there in the pile?

EXERCISE 179.—WRITTEN

1. How many cord feet are there in a pile of wood 96 ft. long, 16 ft. wide, 12 ft. high?

2. How many cords can be piled in a woodhouse 12 ft. $\times 16\frac{1}{2}$ ft. $\times 11\frac{1}{4}$ ft.?

3. Find the number of cord feet in a pile of wood 100 ft. long, 25 ft. wide, 25 ft. high. Find the number of cords.

BOARD MEASURE

284. Lumber is bought and sold by **Board Measure.**

285. The unit of Board Measure is the **Board Foot,** which is 1 ft. long, 1 ft. wide, and 1 in. thick. Boards less than 1 in. in thickness are reckoned as though they were 1 in. thick. Boards more than 1 in. thick are sold according to the number of board feet in them, *e.g.*, a board 10′ long, 1′ wide, 2″ thick, contains 20 board feet.

EXERCISE 180.—ORAL

Find the number of board feet in the following:

1. 10 boards $1'' \times 12'' \times 8'$.
2. 10 boards $1'' \times \frac{3}{4}'' \times 11'$.
3. 10 boards $1'' \times \frac{2}{3}'' \times 18'$.
4. 10 boards $2'' \times 9'' \times 10'$.
5. 10 boards $1\frac{1}{2}'' \times 6'' \times 8'$.
6. 10 boards $1\frac{2}{3}'' \times 9'' \times 14'$.

EXERCISE 181.—WRITTEN

Find the number of board feet in the following:

1. 12 planks $3'' \times 8'' \times 12'$.
2. 14 planks $2\frac{1}{2}'' \times 9'' \times 18'$.
3. 18 planks $1\frac{1}{4}'' \times 12'' \times 12'$.
4. 24 planks $1\frac{2}{3}'' \times 26'' \times 16'$.
5. 60 planks $1\frac{1}{3}'' \times 4'' \times 12'$.
6. How much flooring 18′ long, 4″ wide, $1\frac{1}{2}''$ thick

must be bought to floor a room $18' \times 12'$? What will the flooring cost at \$60 per M?

ROUND LOGS

286. Round logs are sold by the number of board feet that can be cut from them. To find the number of board feet in a log, subtract twice the diameter in inches from the square of the diameter; $\frac{21}{40}$ of the remainder will be the number of board feet in 10 linear feet of the log.

Find the number of board feet in a log 18′ long, 12″ in diameter.

$$12^2 - (2 \times 12) = 144 - 24 = 120$$
$$\tfrac{21}{40} \text{ of } 120 = 63$$
$$\tfrac{18}{10} \text{ of } 63 = 113.4 \text{ board feet.}$$

EXERCISE 182. — WRITTEN

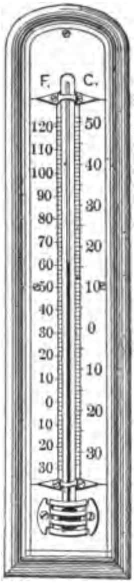
Find the number of board feet in the following:

1. In a log 12′ long, 10″ in diameter.
2. In a log 18′ long, 15″ in diameter.
3. In a log 14′ long, 18″ in diameter.
4. In a log 15′ long, 22″ in diameter.

MEASURING TEMPERATURE

287. Temperature is commonly measured in this country in degrees by Fahrenheit's thermometer. The 32-degree mark is placed at the freezing-point of water, the 212-degree mark at the boiling-point of water. The interval between the freezing-point and the boiling-point is divided into 180 equal degrees. Another thermometer used in many other countries and in most scientifc work

is the Centigrade, with zero at the freezing-point, 100 degrees at the boiling-point. Below zero is indicated by the – sign. Above zero is indicated by the + sign or by no sign.



EXERCISE 183.—ORAL

Unless otherwise stated, Fahrenheit degrees are to be understood in the following problems:

1. When the temperature of the air is 40 degrees, how much above freezing is it?

2. When water is at 180 degrees, how much below boiling is it?

3. The body temperature of a person is normally 98.6 degrees. A temperature of 99 degrees or more indicates fever. What is the range between normal temperature and fever temperature?

4. A body temperature of 108 degrees usually indicates approaching death. What is the range between normal temperature and the death point? Only rarely does the body temperature fall below 92 degrees and life continue. What is the range of temperature?

5. How many degrees Centigrade equal 180 degrees Fahrenheit?

6. How many degrees Fahrenheit equal 1 degree Centigrade?

7. How many degrees Centigrade equal 1 degree Fahrenheit?

EXERCISE 184. — WRITTEN

1. Change 10° F. to C.; change 10° C. to F.

2. Devise a rule for changing from Fahrenheit to Centigrade.

3. Devise a rule for changing from Centigrade to Fahrenheit?

LONGITUDE AND TIME

EXERCISE 185. — ORAL

1. The earth appears to be flat. If it were really flat, what would be true concerning the time of sunrise on every part of the earth's surface?

2. What would be true of sunset under the same conditions? What are the facts concerning the time of sunrise and sunset upon different parts of the earth's surface?

3. Which city has sunrise first, New York or Chicago? Why? Chicago or San Francisco? Why?

4. What places upon the earth have sunrise at the same time? What places have noon at the same time? What places have midnight at the same time?

288. A **meridian** is an imaginary line running north and south from pole to pole. All places upon the same meridian have their midday or noon at the same moment, *i.e.*, they are touched by the vertical rays of the sun at the same time.

289. The distance east or west from a given meridian is called **Longitude**.

EXERCISE 186.—ORAL

1. Through how many degrees does the earth rotate from sunrise until the sun is in the zenith?

2. Through how many degrees does the earth rotate from sunrise to sunset? Through how many degrees does a point upon the earth pass in a complete rotation?

3. Since the earth turns on its axis through 360 degrees in 1 day of 24 hours, through how many degrees does it turn in 1 hour?

290. Longitude is measured by degrees. The meridians from which longitude is commonly reckoned are two, one of which passes through Washington, D.C., one through Greenwich, England.

291. The given meridian from which longitude is generally reckoned is called the **Prime Meridian**. Longitude is reckoned east and west of the prime meridian to 180 degrees. West longitude is designated by the letter "W." and east longitude by the letter "E."

EXERCISE 187.—ORAL

1. When it is sunrise at Baltimore, how long will it be before it is sunrise at a place 15 degrees west of Baltimore? 30 degrees west? 45 degrees west?

2. When it is noon at St. Louis, how long will it be before it is noon at a place 15 degrees west of St. Louis?

3. If I travel eastward, will my watch become too slow or too fast? If I travel westward, will my watch become too slow or too fast?

292. Since the earth turning upon its axis once in 24 hours, passes through 360 degrees in that time, the following table may be deduced:

Longitude		Time
360°	corresponds to	24 hours.
15°	corresponds to	1 hour.
15′	corresponds to	1 minute.
15″	corresponds to	1 second.
1°	corresponds to	4 minutes.
1′	corresponds to	4 seconds.

293. Two places are 40° 15′ 30″ apart. What is the difference in time between them?

$$15\overline{)40^\circ \quad 15' \quad 30''}$$
$$2 \text{ hrs. } 41 \text{ mins. } 2 \text{ secs.}$$

Since places 15° distant from each other have a difference of 1 hr. in time, and since places 15′ apart have a difference of 1 min. in time, and since places 15″ apart have a difference of 1 sec. in time, $\frac{1}{15}$ of the numbers representing degrees, minutes, and seconds will give the difference in time in hours, minutes, and seconds.

EXERCISE 188. — WRITTEN

1. The difference in longitude between two places is 46 degrees, 20 minutes, 35 seconds. What is the difference in time?

2. Washington is 77° 3′ from Greenwich. What is the difference in time?

The longitude of the following cities is:

Washington,	77°	3′	0″	W.
New York,	74°		3″	W
Paris,	2°	20′	22″	E.

San Francisco,	122° 24′ 15″	W.
Peking,	116° 27′ 30″	E.
Constantinople,	28° 59′	E.
Berlin,	13° 23′ 43″	E.

Find the difference in time between:

3. Washington and Peking.
4. New York and San Francisco.
5. Washington and Constantinople.
6. New York and Paris.
7. San Francisco and Berlin.

294. The difference in time between two places is 5 hrs. 30 mins. 25 secs. What is the difference in longitude?

5 hrs.	30 mins.	25 secs.
		15

Since there are 15 times as many degrees, minutes, and seconds of longitude as there are hours, minutes, and seconds of time, 15 times the number representing the difference in time will give the difference of longitude in degrees, minutes, and seconds.

EXERCISE 189. – WRITTEN

1. The difference in time between two places is 10 hrs. 16 mins. 24 secs. What is the difference in longitude?

Find the difference in longitude between the following places and Greenwich, the difference in time being:

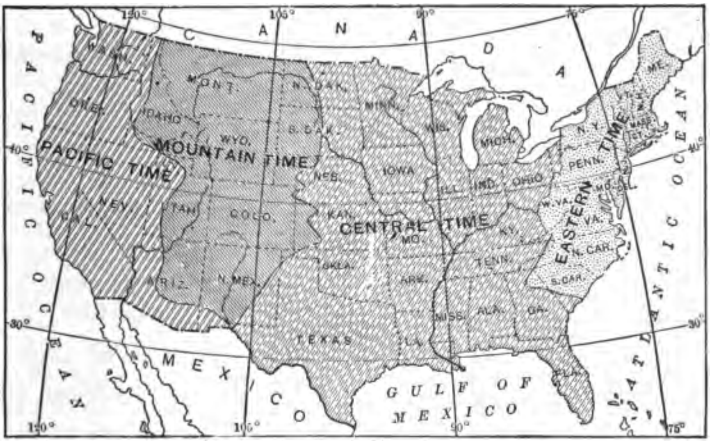
2. Athens, Greece, 1 hr. 34 mins. 54.9 secs. E.
3. Calcutta, 5 hrs. 53 mins. 20.7 secs. E.
4. Chicago, 5 hrs. 50 mins. 26.7 secs. W.
5. St. Petersburg, 2 hrs. 1 min. 13.5 secs. E.
6. What is the difference in longitude between St. Petersburg and Chicago?

7. When it is noon at Greenwich, it is 6.09 A.M. at Chicago. What is the longitude of Chicago?

8. When it is 6.09 A.M. at Chicago, it is 3.50 A.M. at San Francisco. What is the difference in longitude?

STANDARD TIME

295. To use the exact sun time for each place brings about so many complications that another method has been devised by which the world is divided into 24 time-



STANDARD TIME MAP

belts, all places within the same belt using the same time. The time meridians of the time-belts of the United States are those of 75°, 90°, 105°, and 120°, as is shown in the accompanying map. Accordingly, the United States and Canada are divided into four belts extending north and south. All places in the same belt have the same time regardless of their exact longitude. In practice, these

belts do not have regular boundaries; but the points of change are determined rather by the position of important cities. Time determined in this manner is known as **Standard Time.**

EXERCISE 190. — ORAL

1. When it is noon at Greenwich, what time is it at New York, estimating the longitude at New York as 75°?

2. When it is 6 A.M. at New York, what time is it at Chicago? At Denver? At San Francisco?

EXERCISE 191. — WRITTEN

1. What is the difference between standard and local time at Chicago?

2. The longitude of Pittsburg is 80° 2′ 0″. What is the difference between standard and local time there?

3. What is the difference between standard and local time at New Orleans, longitude 90° 3′ 28.5″?

4. The longitudes of St. Louis, Richmond, Denver, and Boston are respectively: 90° 15′ 15″ W., 77° 26′ 4″ W., 104° 59′ 33″ W., 71° 3′ 30″ W. At what time, standard, will an electric time signal sent from Washington at noon reach them? At what local time?

REVIEW PROBLEMS

EXERCISE 192. — WRITTEN

1. How many barrels of water will a trough hold, if it is 7 ft. long, 2 ft. wide, 16 ins. deep?

2. If a windmill pumps 2 gals. and 3 qts. each minute and pumps 4 hrs. in a day, how many cows will it supply if each cow consumes 1.5 cu. ft. of water daily?

3. How many pounds of water does each cow consume if one gallon weighs 8.35 lbs.?

4. A pound of timothy seed contains 1,170,500 seeds. Sowing 16 lbs. to the acre, how many seeds are sown to the acre? How many seeds are there in an ounce?

5. What is the value of a rectangular field 23 chs. 2 rds. 17 lks. 6 ins. long by 17 chs. 3 rds. 13 lks. 7 ins. wide at $37.50 an acre?

6. There are 15 steps on the hall stairs. The tread is 12″, the rise $7\frac{1}{2}$″. What will sufficient stair carpet cost at 62 cts. a yard, allowing $\frac{1}{10}$ extra carpet for the projection of the tread?

7. In raising Irish potatoes three grades of seed were used: 1st, seed from the best hills to be found; 2d, seed from ordinary hills; 3d, seed from the very poor hills. The yields for each 100 hills planted with these seed were: ordinary seed 136 lbs. 14 ozs., best seed 172 lbs. 8 ozs., poor seed 75 lbs. 10 ozs. What was the average yield per hill? What was the increase in yield from seed No. 1 over that of No. 2? Of seed No. 2 over seed No. 3?

8. Sprayed grapes yielded 4 lbs. 5.8 ozs. to the row. Unsprayed grapes yielded 1 lb. 1.5 ozs. to the row. What was the gain per row in pounds from spraying?

9. Sprayed grapes yielded 3 lbs. 4.3 ozs. more per row than unsprayed grapes. What was the difference in yield on $17\frac{7}{8}$ rows?

10. Western Yellow Pine in Colorado, 20 years old, measured 1.2 ins. in diameter; at 30 years, 2.9; at 40, 4.9; at 50, 6.8; at 60, 8.6; at 70, 10.2; at 80, 11.7; at 90, 12.8; at 100, 13.8; at 110, 14.7; at 120, 15.5. What

was its circumference at each of these ages? How much did the diameter increase from the fourth to the fifth decade? How much the circumference? How much did both the diameter and the circumference increase from the eleventh to the twelfth decade?

11. An ordinary milk pail is $11\frac{1}{4}$ ins. in diameter at the top; another pail has an opening only 7 ins. in diameter. What is the difference in the areas of the openings? If seven billion bacteria fall into the milk in the first pail in 15 mins., at the same rate how many would fall into the other pail in the same time?

12. Planting 7 ozs. of tomato seeds to the acre, how many pounds are needed for 19 A.?

13. Sowing 3 pks. of cow-peas to the acre, how many bushels of seed are needed for 40 A.?

14. Bordeaux mixture consists of 5 lbs. of bluestone, 5 lbs. of lime, and 50 gals. of water. Applying this to potatoes at the rate of 150 gals. of mixture to the acre, for each application, and making 3 applications: *a.* How many gallons will be needed on 40 A.? *b.* How many barrels? *c.* What will the bluestone cost at 6 cts. a pound? *d.* What will the lime cost at $1\frac{1}{4}$ cts. a pound?

15. To produce 1 T. of oats requires 376 T. of water. How many cubic feet of water are needed? How many barrels? How many hogsheads? How many quarts?

16. To produce a ton of wheat requires 338 T. of water. Solve for all the items of the last problem.

17. To produce a ton of dry matter, the average crop plant requires 325 T. of water. Solve as in problem 15.

18. A man sells 7 customers 1 pt. each of syrup at 5 cts. a pint, 9 customers $1\frac{1}{2}$ qts. each at 10 cts. a quart, and 13 others 1 gal. each at 35 cts. a gallon. How much a gallon did he average for his syrup?

19. A horse moving at 2:40 gait, moves how far in 1 sec.? At a 2:10 gait? At a 3-min. gait? At a 4-min. gait?

20. What is the cost of materials for 1 cu. yd. of concrete made of 1.16 bbls. of cement @ $2, 0.44 cu. yd. of sand @ 75 cts., 0.88 cu. yd. of gravel @ 75 cts.? If 20 posts $6'' \times 6''$ at the bottom, $6'' \times 3''$ at the top, and $7'$ long, can be made from 1 cu. yd. of concrete, what will the materials cost per post?

21. Adding 6 cts. for 28 ft. of 0.16-in. steel wire @ 3 cts. a pound, what is the total cost for materials per post?

22. A well is 7 ft. in diameter. What is its circumference? If it contains 6 ft. of water, how many gallons are there?

23. A tree has a circumference of 12 ft. What is its diameter? If 8 ft., what is the diameter?

24. The triangular end of a house gable is 37 ft. on its base, and 16 ft. from the base line to apex. What is its area in square feet?

25. A triangular garden has a base of 90 ft. and an altitude of 75 ft. What fraction of an acre is it?

26. A cistern is 12 ft. deep and has a diameter of 8 ft. What is the volume of the cistern? How many gallons of water will it hold?

27. The water pipes on a house measure 13 ins. outside

circumference. There are 200 ft. of piping on the house. What is the surface of this piping?

28. How many cubic feet are there in a cylindrical tank 12 ft. in diameter and 20 ft. deep? How many gallons? How much does the water in it weigh when it is full? How many square feet in its outer surface, exclusive of bottom? How many gallons of water does it contain for each foot in depth?

29. How many feet of picture moulding are needed for a room 17′ 6″ long and 9′ 9″ wide?

30. What is the length of the tire of a wheel 4 ft. in diameter? Of a wheel $3\frac{1}{2}$ ft. in diameter?

31. Mr. Akers owned a rectangular piece of land, the north and south sides of which were each 42 rds. long. The east and west sides were each 38 rds. long. Two railroads cut off portions of it; one took all west of a line beginning at the N. W. corner and running S. E. to a point 14 rds. east of the S. W. corner. The other took all east of a line beginning at a point 12 rds. south of the N. E. corner and running S. W. to a point 8 rds. west of the S. E. corner. Draw a map of the land as cut off by the railroads. The railroad owners bought the land cut off by their roads at $150 an acre. How much did it cost? How much land was left in the tract?

32. How much lumber will be required for 80 rds. of fence 4 boards high, each board 6 ins. wide? How much lumber will be required to make a tight board fence the same length and 5 ft. high, nailing the boards to two 2″ × 4″ scantling? No allowance for waste in either case.

33. How many yards of 27-in. velvet carpet with 22-in.

border will be required to carpet a society hall 42 ft. long, 36 ft. wide, having one rectanglar alcove at each end? Each alcove is 5 ft. deep and $20\frac{1}{2}$ ft. wide. Estimate the amount with strips of carpet running lengthwise.

34. Estimate with strips running crosswise.

35. What will carpet and border cost at $1.25 a yard?

36. How much paper will be needed to paper the walls and ceiling of this hall, there being 4 windows $9\frac{1}{2} \times 6$ ft. and the pitch of the ceiling being 14 ft.? The alcove ceilings are papered, but the alcove walls are finished in hard-wood panels, and require no paper.

37. The paper for walls costs 95 cts. per double roll, for ceiling 25 cts. per double roll, picture moulding 7 cts. a foot, no moulding being used in the alcove. What is the cost?

38. Estimate in meters the height of Mt. Everest 29,002 ft., Pikes Peak 14,111 ft., Mt. Blanc 15,744 ft., and Mt. Aconcagua 23,082 ft.

39. What number of bricks is needed for a wall $4\frac{1}{2}$ ft. high, 3 bricks thick, around an enclosure 14×23 ft.?

40. How many cubic yards of concrete are required to make a circular wall 8 ins. thick around the top of a well, the wall to be 29 ins. high and 5 ft. 3 ins. inside diameter?

41. How many cubic yards of concrete are needed to make a semicircular walk in front of a schoolhouse, the walk to be 4 ft. 3 ins. wide, 27 ft. long on its shorter side, and the concrete to be laid 4 ins. thick?

42. A farmer uses a potato crate $19\frac{3}{8}'' \times 13'' \times 12''$ to contain a bushel of potatoes, 60 lbs. How much does

this bushel of potatoes exceed in size the standard bushel of dry measure?

43. A crate $22'' \times 11\frac{3}{4}'' \times 14\frac{1}{4}''$ contains how many such bushels? How many standard dry bushels?

44. A tank of a spraying machine is in the form of a half-cylinder resting on its convex side, 5 ft. long and 2 ft. $5\frac{3}{4}$ ins. in diameter, inside measurement. What is its capacity? If it were shortened 5 ins. and increased in height $3\frac{1}{4}$ ins. without further curving of the sides, what would the capacity be?

45. The usual 40-qt. milk can is $12\frac{1}{2}$ ins., inside diameter. How many inches tall need it be if of uniform diameter? What fraction of an inch in depth equals 1 qt.?

46. In the usual 50-qt. milk can, 1 qt. occupies .375 in. in depth. What is the diameter of the can?

SILOS AND SILAGE

47. The base of a silo is 16 ft. in diameter. What is its circumference? If 26 ft., what is its circumference?

48. Find the capacity, in tons, of a silo 10 ft. in diameter and 20 ft. high, if a cubic foot of silage from such a silo weighs 30 lbs.

49. How many tons of silage will this silo contain, if, after it has settled, the silage is 5 feet from the top?

50. Find how many tons of silage a silo will hold, that is 20 feet in diameter and 32 feet deep, if in such a silo a cubic foot of silage weighs 40 pounds.

51. How many tons of silage will there be in this silo, if, after it has settled, the silage is 7 feet from the top?

52. If 43 cows be fed 37 lbs. each of silage per day, how long will the contents of this silo last?

53. In order that the silage may settle sufficiently to insure its preservation, a silo should not be less than 30 ft. deep. What diameter must it have to hold enough silage to feed 25 cows 40 lbs. per day for 185 days, if the silage weighs 38 lbs. to the cubic foot?

54. How many acres of corn will it take to furnish a feed of 35 pounds per day each to a herd of 32 cows for 150 days, each acre yielding 12 tons of silage? What must be the diameter of the silo necessary to hold this silage, if the height of the silo is 32 feet, and 1 cubic foot of silage weighs 40 pounds?

55. The corn on a field of 18 acres when ready for cutting and shocking or for putting in the silo weighs 9 tons per acre, of which $\frac{79}{100}$ is water. If by cutting and shocking the corn, there is a loss in dry matter of $\frac{31}{100}$, and by putting it in a silo there is a loss of dry matter of $\frac{1}{10}$, what is the value of the feed gained by putting the crop in the silo, if the dry matter in silage is worth .71 of a cent per pound?

56. How many acres of corn will it require to produce

the silage to feed 18 cows 37 pounds per day for 184 days, if each acre produces 13 tons of silage corn?

DRESSMAKING

57. How many yards of 36-in. material will be required to make a shirt-waist, if the tucked front measures 24 ins. before tucking and the two backs 12 ins. before tucking; the front length from shoulder measuring 18 ins. and two backs 16 ins.; sleeves 16 ins. long before finishing and 18 ins. wide in the widest place? Cuffs, collars, belts are found in pieces cut from strips. See diagram.

58. How many yards of insertion will be required for this waist for 4 strips the length of the front, 4 strips for the back, one piece for the neck 12 ins., and two pieces for the sleeves 8 ins. each?

59. How many yards will be required for a nine-gore skirt of the same linen if gores average 5 ins. wide at the top, and 15 ins. wide at the bottom, the length of each gore being 38 ins. when finished with a 3-in. hem, and allowing 1 in. at the top for finishing?

60. How much insertion will be required for two rows 5 and 3 inches from the bottom of the skirt, if the gores for the bottom row average 13 ins. and second row 12 ins.?

61. At 50 cts. for linen and 15 cts. a yard for insertion, 1 doz. buttons at 10 cts., 1 bolt of tape at 5 cts., what will the dress cost?

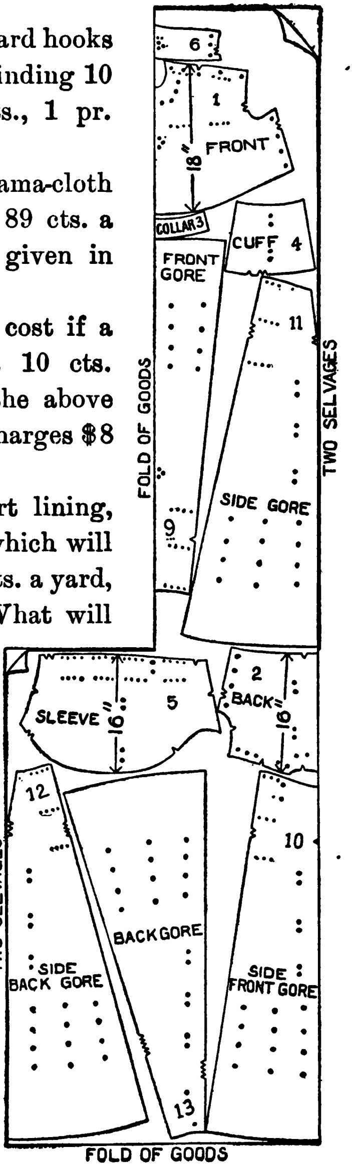
62. The lining and finishings for a dress are called the findings. What will findings consisting of the following items cost: $2\frac{1}{2}$ yds. of waist lining at 15 cts., 6 yds. skirt lining at 25 cts., 2 spools silk at 10 cts., 1 spool cotton

5 cts., 1 bolt braid 10 cts., 1 card hooks and eyes 10 cts., 1 bolt silk binding 10 cts., 1 yd. featherbone 5 cts., 1 pr. shields 35 cts.?

63. Find the cost of a Panama-cloth dress; 8 yds. of material at 89 cts. a yard, with findings at price given in last problem.

64. What will the dress cost if a professional shopper charges 10 cts. on each dollar for buying the above materials and a dressmaker charges $8 for making the dress?

65. If, for the cotton skirt lining, a silk lining be substituted which will require 10 yds. of silk at 59 cts. a yard, what will the dress cost? What will be the shopper's fee?



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66. Races are run at the Olympic games at Athens over distances of 100 meters, 400 meters, 800 meters, 1500 meters. How many yards in each of these distances?

67. The best time for these races prior to 1908 was respectively $10\frac{4}{5}$ secs., $49\frac{1}{5}$ secs., 1 min. 56 secs., and 4 mins. $5\frac{2}{5}$ secs. What was the speed per yard in each race?

68. Some races run in the Public Schools' Athletic League, high school events, are 100 yds., 440 yds., 880 yds., and 1 mi. What is the difference between these distances and those mentioned in problem 66?

69. The time for these races was respectively $10\frac{3}{5}$ secs., 53 secs., 2 mins. $7\frac{2}{5}$ secs., and 4 mins. $59\frac{4}{5}$ secs. What was the speed per yard?

70. Some Olympic records are: running long jump 24 ft. 1 in.; running high 6 ft. $2\frac{4}{5}$ ins.; pole vault 11 ft. 6 ins. P. S. A. L. high school records for the same events are respectively: 21 ft., 5 ft. 6 ins., 9 ft. 9 ins. By what fraction does the P. S. A. L. high school record fall short of the Olympic record in these events?

71. The steamship *Lusitania*, in July, 1908, made an average speed of 25.01 knots an hour. One knot equals 6086.7 ft. What was the average speed in miles per day?

72. The *Lusitania* covered the distance from Daunt's Rock to Sandy Hook lighthouse in 4 das. 20 hrs. and 15 mins. What is the distance?

73. What is the speed per second of the circumference of a grindstone 4 ins. in diameter, run at 30 revolutions per minute?

74. Allowing 5 sq. ft. of floor space to each fowl, what may the dimensions of a henhouse be to accommodate 100 fowls? If one side be 14 ft. what will the other dimension be? With lumber at $15 per M, what will the boards for sides and ends cost if 5 ft. 6 ins. high when built square? When built 14 ft. wide? How much does the extra light and ventilation secured by the narrower form of house cost?

PERCENTAGE

296. If a spraying mixture contains 98 parts water, 1 part lime, and 1 part bluestone, how many parts are there in the mixture? How many **hundredths** of the mixture are water? How many hundredths are lime? How many hundredths are bluestone?

Of a number of seeds tested, one out of every ten fails to grow. How many fail to grow out of every hundred? How many hundredths fail to grow?

The number of hundredths of a number is commonly expressed by the term **per cent.**

Out of 100 oak leaves examined, 60 were injured by insects. What per cent were injured by insects? What per cent were uninjured?

297. The term *per cent* is expressed by the sign %, *e.g.*, 8% is read 8 per cent.

298. A given per cent, or a given number of hundredths, of a number may be expressed as a whole number with the per cent sign, as a decimal, or as a common fraction, *e.g.*; 1 per cent may be written 1%, .01, or $\frac{1}{100}$. 8 per cent may be written 8%, .08, or $\frac{8}{100}$.

EXERCISE 193. – WRITTEN

Express as decimals:

1. 4%.	**4.** 15%.	**7.** $6\frac{2}{3}$%.	**10.** $62\frac{1}{2}$%.
2. 6%.	**5.** 75%.	**8.** $5\frac{3}{4}$%.	**11.** $83\frac{1}{3}$%.
3. 5%.	**6.** $4\frac{1}{2}$%.	**9.** $9\frac{1}{3}$%.	**12.** 115%.

13. $125\frac{1}{2}\%$.	**16.** 2.25%.	**19.** $.4\%$.
14. 250%.	**17.** 6.4%.	**20.** $.04\%$.
15. $63\frac{1}{2}\%$.	**18.** 9.34%.	**21.** $.004\%$.

299. Express 25%, 2.5%, $\frac{1}{4}\%$, as common fractions in lowest terms:

$$25\% = \tfrac{25}{100} = \tfrac{1}{4}.$$
$$2.5\% = \tfrac{2.5}{100} = \tfrac{25}{1000} = \tfrac{1}{40}.$$
$$\tfrac{1}{4}\% = \frac{\frac{1}{4}}{100} = \tfrac{1}{400}.$$

EXERCISE 194. — WRITTEN

Express as common fractions in lowest terms:

1. 12%, $.12\%$.	**6.** $16\frac{2}{3}\%$, $\frac{1}{6}\%$.	**11.** 150%, $.15\%$.
2. 25%, $.25\%$.	**7.** $33\frac{1}{3}\%$, $\frac{1}{3}\%$.	**12.** 625%, 6.25%.
3. 42%, $.42\%$.	**8.** $62\frac{1}{2}\%$, $\frac{5}{8}\%$.	**13.** 375%, 3.75%.
4. 55%, $.55\%$.	**9.** $83\frac{1}{3}\%$, $\frac{5}{6}\%$.	**14.** $\frac{3}{4}\%$, 1.2%.
5. 75%, $.75\%$.	**10.** $12\frac{1}{2}\%$, $\frac{1}{8}\%$.	**15.** $\frac{1}{2}\%$, $.05\%$.

300. Express $\frac{1}{2}\%$, $\frac{1}{5}\%$, $\frac{2}{10}\%$, as decimals of a per cent, and as decimals:

$$\tfrac{1}{2}\% = .5\% = .005.$$
$$\tfrac{1}{5}\% = .2\% = .002.$$
$$\tfrac{2}{10}\% = .2\% = .002.$$

EXERCISE 195. — WRITTEN

Express the following as decimals, and as decimals of a per cent:

1. $\frac{1}{4}\%$.	**4.** $\frac{1}{5}\%$.	**7.** $\frac{2}{3}\%$.	**10.** $\frac{3}{10}\%$.
2. $\frac{1}{6}\%$.	**5.** $\frac{1}{4}\%$.	**8.** $\frac{1}{8}\%$.	**11.** $\frac{7}{8}\%$.
3. $\frac{1}{3}\%$.	**6.** $\frac{3}{4}\%$.	**9.** $\frac{2}{5}\%$.	**12.** $\frac{5}{12}\%$.

13. $\frac{1}{9}\%$.	**15.** $\frac{5}{6}\%$.	**17.** $\frac{3}{7}\%$.	**19.** $\frac{5}{8}\%$.
14. $\frac{4}{5}\%$.	**16.** $\frac{9}{16}\%$.	**18.** $\frac{3}{8}\%$.	**20.** $\frac{3}{5}\%$.

301. Important per cents to be remembered:

$1 = 100\%$.	$\frac{3}{4} = 75\%$.	$\frac{1}{8} = 12\frac{1}{2}\%$.	$\frac{1}{15} = 6\frac{2}{3}\%$.
$\frac{1}{2} = 50\%$.	$\frac{1}{5} = 20\%$.	$\frac{3}{8} = 37\frac{1}{2}\%$.	$\frac{1}{20} = 5\%$.
$\frac{1}{3} = 33\frac{1}{3}\%$.	$\frac{3}{5} = 60\%$.	$\frac{5}{8} = 62\frac{1}{2}\%$.	$\frac{1}{25} = 4\%$.
$\frac{2}{3} = 66\frac{2}{3}\%$.	$\frac{1}{6} = 16\frac{2}{3}\%$.	$\frac{7}{8} = 87\frac{1}{2}\%$.	$\frac{1}{50} = 2\%$.
$\frac{1}{4} = 25\%$.	$\frac{5}{6} = 83\frac{1}{3}\%$.	$\frac{1}{10} = 10\%$.	$\frac{1}{100} = 1\%$.

EXERCISE 196.—ORAL

Find:

1. 10% of 50.	**6.** $37\frac{1}{2}\%$ of 48.	**11.** $16\frac{2}{3}\%$ of 66.
2. 25% of 80.	**7.** $87\frac{1}{2}\%$ of 72.	**12.** $62\frac{1}{2}\%$ of 64.
3. 60% of 300.	**8.** 5% of 125.	**13.** 60% of 10.
4. $12\frac{1}{2}\%$ of 72.	**9.** 2% of 200.	**14.** $83\frac{1}{3}\%$ of 42.
5. $16\frac{2}{3}\%$ of 90.	**10.** $83\frac{1}{3}\%$ of 96.	**15.** 5% of 120.

EXERCISE 197.—WRITTEN

Find:

1. 75% of 1280.	**8.** $66\frac{2}{3}\%$ of 5432.
2. $\frac{1}{4}\%$ of 5420.	**9.** 4.2% of 2437.
3. 2.5% of 2655.	**10.** 42% of 8432.
4. $87\frac{1}{2}\%$ of 6424.	**11.** $\frac{3}{8}\%$ of 9812.
5. 4% of 2254.	**12.** $38\frac{1}{2}\%$ of 5431.
6. $\frac{5}{6}\%$ of 8243.	**13.** 4.5% of 5240.
7. $83\frac{1}{3}\%$ of 9846.	**14.** 8.9% of 1872.

302. The number of which so many hundredths or a certain per cent is to be taken is called the **Base**.

303. The number indicating how many hundredths of the base are to be taken expresses the **Rate** or **Rate Per Cent.**

304. The result obtained by taking the number of hundredths of the base indicated by the rate is the **Percentage.**

Find 9% of 50:

$$\begin{array}{rl} 50 & \text{is the base.} \\ .09 & \text{is the rate.} \\ \hline 4.5 & \text{is the percentage.} \end{array}$$

305. Three kinds of problems occur in percentage:

1. Those in which base and rate are known and percentage is to be found.

2. Those in which base and percentage are known and rate is to be found.

3. Those in which rate and percentage are known and base is to be found.

306. CASE ONE. **Given the base and the rate to find the percentage.**

In testing a certain ore it was found that 25% of it was iron. How much iron was contained in 496 lbs. of ore? Since $25\% = \frac{1}{4}$, the percentage is most readily obtained by taking $\frac{1}{4}$ of 496, which is 124. Hence, 124 lbs. was iron.

In testing an ore it was found that 29% of it was iron. How much iron was there in 469 lbs. of ore?

Since 29% or $\frac{29}{100}$ is not conveniently used as a common fraction, it is best to express it as a decimal, .29. $469 \times .29 =$ 136.01 lbs. Hence 136.01 lbs. was iron.

Knowing the base and rate to find the percentage.

Multiply the base by the rate expressed either as a common or as a decimal fraction.

EXERCISE 198. — ORAL

1. Find 5 % of 80; 120; 40; 200; 180; 160; 20.
2. Find 4 % of 75; 125; 150; 175; 50; 25.
3. Find 10 % of 40; 110; 140; 90; 70; 860; 10.
4. Find 20 % of 30; 75; 90; 65; 95; 100; 25; 5; 10.
5. Find 25 % of 20; 40; 80; 60; 12; 8; 10; 4.
6. Find $\frac{1}{2}$ % of 100; 200; 50.

EXERCISE 199. — WRITTEN

Solve the following, using the rate both as a decimal and as a common fraction:

1. Find 7 % of 425; of 67.3; of 526; of 9642; of 87.9.
2. Find 14 % of 48.8; of 68; of 125.6; of 7981.
3. Find $6\frac{1}{4}$ % of 32; of 96.32; of 128.64; of 842.
4. Find 19 % of 33; of 99; of 132; of 869; of 7684.
5. Find 72 % of $\frac{1}{4}$; of $\frac{3}{17}$; of $\frac{9}{24}$; of $\frac{8}{97}$; of $\frac{16}{18}$.
6. What is 15 % of $5.20? of $13.50? of $75? of $8764.75?
7. What is 4 % of $\frac{1}{8}$ of an acre of land?
8. What is 13 % of 96 sq. chs. 48 sq. rds. of land?
9. What is 37 % of 1 sq. mi. 168 sq. rds. of land?
10. Find 129 % of 76; of 128; of 7842.1.
11. Find 300 % of 84; of 78.2; of 3.
12. Find .3 % of 782; of 6498.

13. Find .17 % of 6842; of 17; of 386.7.

14. Find .06 % of 98; of 782; of 6428.

15. A owned $\frac{3}{8}$ of a mill and sold $33\frac{1}{3}$ % of his share. What part of the mill did he sell, and what part does he still own?

307. Case Two. **Given the base and the percentage to find the rate.**

What per cent of 85 is 17?

Dividing 17 by 85, we have $\frac{17}{85} = \frac{1}{5}$.
$\frac{1}{5}$ of any number is 20 % of that number, therefore 17 is 20 % of 85.

Since the percentage is found by multiplying the base by the rate, the rate may be found by dividing the percentage by the base.

What per cent of 85 is 17.85? base = last yrs figure

85 last yr.
67.15 this yr.
17.85

percentage = dif. between last yr. and this

$$
\begin{array}{r}
.21 \\
85\overline{)17.85} \\
\underline{1700} \\
85 \\
\underline{85}
\end{array}
$$

Dividing 17.85 by 85, we have .21 = 21 %.
Therefore, 17.85 is .21, or 21 hundredths, or 21 % of 85.

EXERCISE 200. — ORAL

1. What per cent of 50 is 25? Is 10?
2. What per cent of \$5.00 is \$125? Is \$2.50?
3. What per cent of \$12.50 is \$3.00? Is \$2.75?
4. What per cent of \$72.50 is \$15.50? Is \$17.40?
5. What per cent of 96 is 31? Is 27?
6. What per cent of 122 is 6.1? Is 9.76?

EXERCISE 201. — WRITTEN

1. What per cent of 86 is 24? Is 8? Is 1? Is $\frac{1}{4}$?

2. What per cent of 7862 is 18? Is 986? Is 12? Is 7?

3. What per cent of 7847 is 67? Is 7614? Is 96?

4. What per cent of 848 is 424? Is 212? Is 106?

5. What per cent of 1 is $\frac{1}{2}$? Is $\frac{3}{4}$? Is .08?

6. A man whose salary is $132 a month pays $26.40 for board, and $5.28 for amusement. What per cent of his salary remaining after his board is paid, does he pay for amusement?

7. A workingman's day is 10 hours long. He spends $\frac{4}{7}$ of the remaining hours in sleep. What per cent of his time is given to sleep? What per cent to other pursuits?

8. A farmer held cotton bought of a renter; the price declined 12%, then rose 15%; he then sold. What per cent did he gain on the transaction?

9. If a merchant's scales weigh 14 ozs. for a pound, what per cent does the purchaser lose?

10. If the retail merchant's fair profit is equivalent to 3 ounces and the scales are as in the above example, what per cent more does the buyer pay than if he were to buy from wholesale houses?

11. What per cent of a number is $33\frac{1}{3}$% of 6% of it?

308. Case Three. **Given the rate and the percentage to find the base.**

29 is 20% of what number?

20% $= \frac{20}{100}$, or $\frac{1}{5}$. 29 is therefore $\frac{1}{5}$ of the base; the base is

$29 \div \frac{1}{5} = 29 \times \frac{5}{1}$, or 29 multiplied by 5, or 145, or expressing 20% as a decimal $= .20 = .2$, and dividing we have,

$$\begin{array}{r} .2\overline{)29.0} \\ 145. \end{array}$$

The second method is preferable when the rate cannot readily be expressed as a fraction.

Since the percentage is the product of the rate and the base, the base may be found by dividing the percentage by the rate expressed as a decimal.

EXERCISE 202.—ORAL

1. 8 is 5% of what number? 10% of what number?
2. 8 is 20% of what number? 25% of what number?
3. 12 is $12\frac{1}{2}$% of what number? 75% of what number?
4. \$2.50 is $16\frac{2}{3}$% of what? $33\frac{1}{3}$% of what?
5. 6 ft. 10 ins. is $66\frac{2}{3}$% of what? $33\frac{1}{3}$% of what?
6. 21 ft. 7 ins. is $87\frac{1}{2}$% of what?
7. 16 gals. 4 qts. 2 pts. is $87\frac{1}{2}$% of what?

EXERCISE 203.—WRITTEN

1. 44.1 is 105% of what number? 90% of what number?
2. 60 is 125% of what number? 75% of what number?
3. 96 is 30% of what number? 18% of what number?
4. 47 is 8% of what number? 20% of what number?
5. 776 is 60% of what number? 83% of what number?
6. 6 is 16% of what number? 90% of what number?
7. 87 is .05% of what number? 178% of what number?

309. When the base is added to the percentage, the sum is known as the **Amount.**

310. When the percentage is subtracted from the base, the remainder is called the **Difference.**

311. The rent of a farm is $68.20 and this is an advance of 10 % over the previous year. What was the rent the previous year?

$$
\begin{aligned}
100\,\% &= \text{rent the previous year.}\\
10\,\% &= \text{advance this year.}\\
110\,\% &= \$68.20.\\
1\,\% &= .62.\\
100\,\% &= \$62.
\end{aligned}
$$

Hence, $62 was the rent of the farm for the previous year.

A regiment returns from battle with 1197 men, which is 5 % less than it started with. How many men were in the regiment when the battle began?

$$
\begin{aligned}
100\,\% &= \text{number started with.}\\
5\,\% &= \text{number lost.}\\
95\,\% &= 1197.\\
1\,\% &= 12.6.\\
100\,\% &= 1260.
\end{aligned}
$$

To find the base when the rate and amount are given, divide the amount by 1 plus the rate expressed as a decimal.

To find the base when the rate and difference are given, divide the difference by 1 minus the rate expressed as a decimal.

EXERCISE 204. — ORAL

1. Amount 110, rate 10; find the base.
2. Amount 150, rate 50; find the base.

3. Amount 75, rate 50; find the base.
4. What number plus 7 % of itself equals 214?
5. What number minus 10 % of itself equals 90?

EXERCISE 205.—WRITTEN

	Base	Percentage	Rate	Amount	Difference
1	17.62	.75	7%	647	784
2	1784.2	1.50	$5\frac{1}{2}$%	829	679
3	368.0	7.84	27%	36.89	87.24
4	42.879	26.75	219%	726.47	629.84
5	6784.0	179.50	0.6%	$99\frac{7}{8}$	$88\frac{7}{8}$
6	20090.0	$16\frac{7}{11}$	$\frac{6}{7}$%	$642\frac{9}{17}$	$79\frac{16}{35}$
7	6425.7	$\frac{5}{18}$	0.08%	$\frac{7}{8}$	$\frac{9}{11}$
8	$84\frac{3}{4}$	$6\frac{4}{7}$	0.009%	0.06	0.098
9	$\frac{9}{16}$	0.074	0.01	8.09	$9.99\frac{9}{11}$
10	.0086	6.28	0.6	7.09	$6.4\frac{7}{8}$

The pupil should practise with these problems enough to attain skill, accuracy, and certainty.

1–10. Using the base in line 1, find the percentage with the rate given in each line from 1 to 10.

11–40. Using bases in lines 2, 3, and 4, find percentages with each rate given.

41–80. Using the percentages in lines 4, 5, 6, and 7, with each rate given, find the bases.

81–120. Using the bases given in lines 3, 4, 5, and 6, with each percentage given, find the rates.

121–160. Using the amounts given in lines 6, 7, 8, and 9, find the bases with each rate given.

161–200. Using the differences given in lines 1, 2, 3, and 4, find the bases with each rate given.

EXERCISE 206.—WRITTEN

FARMING IN THE UNITED STATES

1. In 1900, 7.1 % of the farms, or 407,012 farms, were between 10 and 20 A. in area. How many farms were there in the United States then?

2. Of 29,285,922 working inhabitants in the United States in 1900, 10,438,217 were engaged in agriculture, 7,112,987 in manufacturing, and 1,264,735 in professional service. What per cent was engaged in each of these pursuits?

3. $3,560,198,191, the value of the farm buildings of the United States, is 21.4 % of the total farm value. What is the total farm value?

4. Of the 5,739,657 farms in the United States in 1900 54.9 % were worked by their owners, 13.1 % by cash tenants, and 22.2 % by share tenants. How many farms were worked in each of these ways?

5. In 1900, 1,366,167 of the 5,739,657 farms of the United States were between 50 and 100 A. in area. What per cent of farms were of this size? 47,276 were over 1000 A. in area. What per cent did they constitute?

6. In 1900 24.8 % of the farms in the United States were between 100 A. and 175 A. in area. How many farms of this size were there? 21.9 % were between 20 and 50 A. How many were there of this latter class?

7. In 1900 there were 9,349,922 men and boys engaged in farming in the United States, 20.1 % more than in 1890. At the same rate of increase, how many farmers will there be in 1910?

8. In 1894 there were 2712 Agricultural College students in the United States; in 1899, 5035. What was the per cent of increase for these five years?

9. The value of the fertilizers used in the United States in 1899 was $49,099,939. If by home mixing of fertilizers and more intelligent use 23 % of this could be saved, what would be the saving to the farmers of the United States?

IMPORTANCE OF GOOD SEED

10. A certain number of tobacco plants raised from heavy seed produced 12.5 lbs. of tobacco; an equal number of plants raised from light seed gave only 6.4 lbs. What was the per cent of gain by the use of heavier seed?

11. With ordinary tobacco seed yielding 816 lbs. of tobacco per acre, and heavy seed yielding 29 % more, what would be the number of pounds of gain on an acre, if heavy seed were used? Tobacco selling at 8 cts. a pound, what is the gain in value?

12. If a machine to separate heavy seed (see picture) costs $8 and the labor of such separation costs 5 cts. for seed for an acre, what would be the profit per acre the first year, supposing 7 A. were to be raised?

13. What would be the per cent of profit the second year on the same acreage? There is no cost for the machine the second year.

14. It is estimated that by using only the best varieties of corn and selecting the seed by the best-known methods, the corn crop of the United States might be increased 10 %, or $116,662,647, in value. What is the present value of the corn crop?

15. What could be its value if the best methods of seed selection were used?

16. Light and heavy seeds were tested for germinating power. It was found that with lettuce, 44 % of the light seed germinated, 88 % of the heavy seed germinated; onions, 38 % of the light seed germinated, 85 % of the heavy. What was the per cent of increase of the heavy seeds over light seeds in germinating power in each case?

17. If selected heavy cotton-seed yield 8.25 % more than ordinary cotton-seed, what will be the value of the increase in yield on 600 A., averaging $\frac{7}{8}$ of a bale to the acre with the unselected seed, when cotton sells at $56 a bale?

18. If cow-pea stubble plowed under increases the cotton crop of the following year 47 %, and the cotton crop was originally $\frac{2}{3}$ of a bale to the acre, what is the money value of the stubble to the farmer, with cotton at $55 a bale?

19. Heavy cotton-seed produces better plants than does light seed. On 20 rows at Lamar, S.C., heavy seed yielded 1047$\frac{1}{4}$ lbs. of cotton; ordinary seed yielded 944 lbs. What was the per cent of gain by the use of heavy seeds?

20. On another trial, heavy seed gave 1164 lbs. of

cotton; ordinary seed 1075 lbs. What would the gain from the use of heavy seed amount to on a 500-acre plantation averaging $\frac{5}{7}$ of a bale per acre? (500 lbs. equals 1 bale.)

21. What would be the value gained, with cotton at $11\frac{1}{8}$ cts. per pound? What could the planter afford to pay to have seed separated, and still make 12% upon the investment?

22. Which is most economical to buy, *a.* Red clover seed at $5.20 per 100 lbs. containing only 48.06% of real clover seeds and only 38% of them alive; or *b.* Seed at $6.10 per 100 lbs. with 46.24% of real clover seed, 27.5% of which are alive; or *c.* Seed at $7.20 per 100 lbs. with 73.8% real clover seed, 89% of which are alive?

23. One lot of redtop seed at $5.00 per bushel contained 77.4% of good seed; another lot at $1.10 per bushel contained 10.48% of good seed. Which was the cheaper? How much was paid per bushel for good seed in each case?

PREVENTION OF PLANT DISEASES

24. In using 1 oz. of formalin to 3 gals. of water as a steep for oat seed to prevent smut, what per cent of formalin is used? (1 gal. of water weighs $8\frac{1}{3}$ lbs.)

25. How many pounds of formalin will be needed for 25 A., allowing 1 gal. of mixture to each bushel of oats and 2 bus. of oats to the acre? At 38 cts. a pound, what will it cost?

26. Formalin, being 40% formaldehyde, what per cent of formaldehyde is there in a 1-oz.-to-3-gal. mixture?

27. The average net profit from spraying potatoes in experiments carried out during 1906 was $13.89 per acre; the net profit from similar experiments in 1905 was $20.04, in 1904 $24.06, in 1903 $23.43. What was the average benefit for all these years? What would such amount to on 40 A.?

28. Apple trees sprayed and not sprayed for the prevention of worminess yielded as follows:

	Total Yield	Windfalls			Picked Fruit			Total Number of Apples	Per-cent of Sound Fruit
		Wormy	Not wormy	Total	Wormy	Not wormy	Total		
Sprayed:	*Bushels*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*		
Tree 1	14	20	—	188	153	1754	—	—	—
Tree 2	13.25	11	—	102	129	1605	—	—	—
Tree 3	13.75	26	—	78	206	1562	—	—	—
Total	—	—	—	—	—	—	—	—	—
Unsprayed:									
Tree 1	11.75	464	—	502	1258	383	—	—	—
Tree 2	6.875	224	—	248	697	488	—	—	—
Tree 3	5.50	315	—	404	564	428	—	—	—
Total	—	—	—	—	—	—	—	—	—

Copy table and fill each blank.

29. A block of 69 sprayed trees yielded: merchantable fruit, 255 bus.; culls, including windfalls, 36.5 bus. What was the per cent of merchantable fruit?

30. The crop from 10 unsprayed Winesap trees was: salable fruit, 6.75 bus.; culls, including windfalls, 10.25 bus. What was the per cent of salable fruit?

31. The use of Bordeaux mixture to prevent the downy mildew of cucumbers in New York State at an expenditure of $9.50 an acre increased the profit $163.50

an acre. What was the per cent of gain on the amount invested?

32. Three trees affected with bitter rot yielded 21.1 bus. of apples, 188 sound apples and 4244 diseased apples. Six similar trees, sprayed to prevent the rot, yielded 101.3 bus., 8674 sound and 989 diseased. What was the per cent of increase in bushels by spraying? In sound apples? Spraying costs each time $3\frac{1}{2}$ cts. per tree. They were sprayed 3 times. What was the cost of spraying? What was the profit with apples at 85 cts. a bushel?

33. A man plants two fields of 10 A. each with corn. In A he uses seed corn selected in the field; in B he uses seed selected in the barn. The cost of fertilizers and labor for each field was $10 an acre. Field A produced 45 bus. and field B, 36 bus. an acre. The man sold the corn at $.60 a bushel. Allowing $4 an acre for rent of land, what was the profit on each field? What per cent was gained by selecting seed in the field?

34. Two farmers plant 5 A. each in peanuts, using the same kind of seed. Mr. A spends $1.50 for lime, $3.00 for commercial fertilizer, and $2.00 for land plaster to the acre. Mr. B uses the same as the above, except the lime. Rent of land and cost of labor was $7.00 an acre for each. Mr. A made 1500 lbs. and Mr. B 1000 lbs. of peanuts an acre, which they sold at 3 cts. a pound. How much more did Mr. A get for his crop than Mr. B? What per cent was made on the money invested in lime?

ROOT TUBERCLES

35. Cow-peas with tubercles upon their roots yield 139.29 lbs. of nitrogen, without tubercles 118.45 lbs.;

soy beans with tubercles 113.55 lbs., without 75.98 lbs. What is the per cent of additional nitrogen with each of these crops when tubercles are present?

36. If 100 lbs. of cow-pea tops contain: nitrogen 1.84 lbs., phosphoric acid .67 lbs., potash 1.29 lbs.; and 100 lbs. of cow-pea roots contain: nitrogen 1.47 lbs., phosphoric acid .67 lbs. and potash 1.43 lbs.,—what per cent of each of these foods is in the root? What per cent in the tops? In a harvest of 3.2 T. per acre, how much nitrogen is removed? How much potash? How much phosphoric acid?

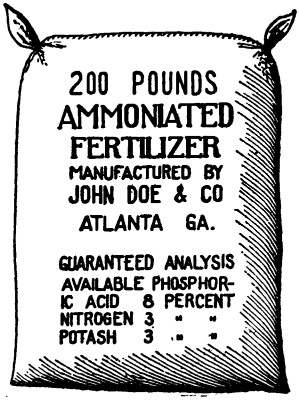
37. The following amounts of fertilizers in each 100 lbs. of dry substance were found in leguminous crops.

Plant and Part	Nitrogen	Phosphoric Acid	Potash
	Pounds	*Pounds*	*Pounds*
Red clover			
Tops	2.28	0.72	1.40
Roots	2.74	0.84	0.82
Alfalfa			
Tops	2.89	0.53	1.46
Roots	2.04	0.43	0,48
Crimson clover			
Tops	2.72	1.10	1.56
Roots	1.50	0.47	1.02
Cow-pea			
Tops	2.79	0.57	2.00
Roots	1.46	0.16	.77

In each crop what per cent of the top is nitrogen? What per cent phosphoric acid? What per cent potash? What per cent of the roots is nitrogen? What per cent potash? What per cent phosphoric acid? By what per cent does the nitrogen of red clover exceed that of cow-peas?

COMMERCIAL FERTILIZERS

312. Commercial fertilizers are used for the nitrogen, phosphoric acid, and potash they contain. The nitrogen, phosphoric acid, and potash are obtained from different substances. Some of these substances contain one, some two, and some all of these plant foods. The substances used for supplying nitrogen, phosphoric acid, and potash in commercial fertilizers contain different per cents of these plant foods. The composition of some of these substances is quite uniform or constant, while in others the per cent of nitrogen, phosphoric acid, and potash varies considerably.



EXERCISE 207. — WRITTEN

1. If ammonia is 82.4% nitrogen, how many pounds of nitrogen are there in a ton of fertilizer that has 2% of ammonia?

2. If there is 1 lb. of nitrogen in 1.214 lbs. of ammonia, how many pounds of nitrogen will there be in a ton of commercial fertilizer which has 6.07% of ammonia?

3. What per cent of nitrogen has a fertilizer which has 3.642% of ammonia?

4. What per cent of ammonia has a fertilizer that has 2% of nitrogen?

5. If a ton of cotton-seed contains 60 lbs. of nitrogen, what per cent of cotton-seed is nitrogen?

6. If cotton-seed meal contains 6.2 % nitrogen, 2.8 % phosphoric acid, 1.8 % potash, how many pounds of each are there in a ton of cotton-seed meal? What is the ton worth for fertilizer, valuing nitrogen at 19 cts. per pound, phosphoric acid at $4\frac{1}{2}$ cts., and potash at 5 cts.?

7. If cotton-seed meal has 7.5 % of ammonia, how many pounds of nitrogen will there be in a ton of cotton-seed meal? How much will the nitrogen be worth at 18 cts. per pound? How much, when the cotton-seed meal has 8 % ammonia?

8. If there are 124 lbs. of nitrogen in a ton of cotton-seed meal, what per cent of cotton-seed meal is nitrogen?

9. If there is 15.8 % of nitrogen in nitrate of soda, how many pounds of nitrogen are there in a ton of nitrate of soda. What will the ton of nitrate of soda be worth, valuing nitrogen at 18 cts. per pound?

10. If a ton of cotton-seed contains 26 lbs. of phosphoric acid, what per cent of cotton-seed is phosphoric acid?

11. If there are 14 lbs. of nitrogen in 17 lbs. of ammonia, and 15.8 lbs. of nitrogen in 100 lbs. of nitrate of soda, how many pounds of ammonia will it take to furnish as much nitrogen as 1 T. of nitrate of soda?

12. If a farmer mixes a fertilizer so as to contain 800 lbs. of a 16 % acid phosphate to the ton, what per cent of phosphoric acid will his fertilizer contain?

13. A farmer is offered a ton of 16 % acid phosphate

at $12.75 a ton, 14 % acid phosphate at $12.00 a ton, or a ton of 12 % acid phosphate for $11.00. Which is the cheapest, and how much cheaper, valuing phosphoric acid at 4 cts. a pound?

14. Which is cheaper, a ton of a 2-8-2 fertilizer (*i.e.*, one containing 2 % of nitrogen, 8 % of phosphoric acid, and 2 % of potash) at $18, or a ton of a 3-8-3 fertilizer (*i.e.*, one containing 3 % of nitrogen, 8 % of phosphoric acid, and 3 % of potash) at $22, valuing nitrogen at 20 cts. per pound, phosphoric acid at 4½ cts. per pound, and potash at 5 cts. per pound?

15. If there are 250 lbs. of potash in a ton of kainit, what per cent of potash is there in kainit?

16. If a ton of cotton-seed contains 24 lbs. of potash, what per cent of cotton-seed is potash?

17. Sulphate of potash contains 4 times as much potash as kainit contains. What per cent of sulphate of potash is potash, if there are 48 lbs. of potash in 384 lbs. of kainit?

18. If there are 1000 lbs. of potash in a ton of muriate of potash, what per cent of muriate of potash is potash?

19. If there are 36 lbs. of potash in a ton of cotton-seed meal, what per cent of cotton-seed meal is potash?

20. If kainit contains 12½ % of potash, and muriate of potash contains 50 % potash, how many pounds of kainit will it take to supply as much potash as there is in 40 lbs. of muriate of potash?

21. If a ton of dried blood contains 280 lbs. of nitrogen, what per cent of dried blood is nitrogen?

22. If a ton of fish scrap contains 180 lbs. of nitrogen, what per cent is nitrogen?

23. If fish scrap contains 8.25 % of nitrogen and 6 % of phosphoric acid, what is a ton of fish scrap worth, allowing 20 cts. per pound for nitrogen and 4 cts. per pound for phosphoric acid?

24. If a ton of wood ashes contains 120 lbs. of potash, what per cent of wood ashes is potash? If a ton contains 130 lbs. of potash, what per cent of wood ashes is potash?

25. If there are 140 lbs. of phosphoric acid in a ton of fish scrap, what per cent of fish scrap is phosphoric acid?

26. If there are 320 lbs. of phosphoric acid in a ton of acid phosphate, what per cent of acid phosphate is phosphoric acid? If there are 280 lbs., what per cent is phosphoric acid? If 240 lbs., what per cent is phosphoric acid? If 200 lbs., what per cent is phosphoric acid?

27. If there are 56 lbs. of phosphoric acid in a ton of cotton-seed meal, what per cent of cotton-seed meal is phosphoric acid?

28. What is a ton of acid phosphate analyzing 16 % phosphoric acid worth, when phosphoric acid is worth 4 cts. a pound?

29. How much is a ton worth when it analyzes 14 %, 12 %, 10 %, and 8 % respectively?

30. If there are 329.4 lbs. of nitrogen in a ton of nitrate of soda, what per cent of nitrate of soda is nitrogen?

The composition of many fertilizing materials varies considerably, but the following is a fair average:

COMPOSITION OF FERTILIZING MATERIALS

	Per Cent of Nitrogen	Per Cent of Potash	Per Cent of Phosphoric Acid
Acid phosphate			16
Acid phosphate			14
Acid phosphate			13
Ground phosphate rock			32
Tobacco stems	1.5	5	2
Sulphate of potash (high grade)		50	
Muriate of potash		50	
Nitrate of potash	13	45	
Kainit		12.5	
Wood ashes (unleached)		6	1.5
Cotton-seed meal	6.2	1.8	2.8
Cotton seed	3	1.2	1.3
Tankage (concentrated)	12		1.5
Dried blood (high grade)	14		
Fish scrap	9		7
Nitrate of soda	15.8		
Sulphate of ammonia	20.5		

31. If in making a ton of fertilizer containing 3.2235% of nitrogen, 9.099% of phosphoric acid, and 3.5815% of potash, 100 lbs. of nitrate of soda are used, what number of pounds of cotton-seed meal, 16% acid phosphate, and of muriate of potash must be used?

32. What per cent of nitrogen, phosphoric acid, and potash will there be in a ton of fertilizer composed as follows: 1000 lbs. of 16% acid phosphate, 700 lbs. of cotton-seed meal, 100 lbs. of nitrate of soda, and 200 lbs. of muriate of potash?

33. What will be the per cent of nitrogen, phosphoric acid, and potash in a fertilizer composed of the following

materials: 800 lbs. of cotton-seed meal, 800 lbs. of 16 % acid phosphate, 400 lbs. of kainit?

34. How many pounds of nitrogen, phosphoric acid, and potash will the ton of fertilizer mentioned in the last problem contain, and what will it be worth at 18 cts. a pound for nitrogen, $4\frac{1}{2}$ cts. a pound for phosphoric acid, and 5 cts. a pound for potash, adding $5 for mixing, bags, and freight?

FEEDS AND FEEDING

313. If corn contains 10.3 % of protein and 76 % of this protein is digestible, what per cent of digestible protein is there in corn?

If corn contains 72.5 % of carbohydrates and 92 % of these are digestible, what per cent of digestible carbohydrates is there in corn?

If 5 % of corn is fats and 86 % of these fats are digestible, what per cent of digestible fat is there in corn?

314. Table of digestible nutrients in certain feeds.

Feeds	Per Cent of Protein	Per Cent of Carbohydrates	Per Cent of Fats
Corn	7.8	66.7	4.3
Oats	9.22	47.3	4.2
Wheat bran	12.2	39.2	2.7
Wheat middlings	12.8	53.0	3.4
Cotton-seed meal	37.2	16.9	12.2
Timothy hay	2.8	43.4	1.4
Red-clover hay	6.8	35.8	1.7
Cow-pea hay	10.8	38.6	1.1
Alfalfa hay	11.10	39.6	1.2
Corn stover	1.7	32.4	0.7
Corn silage	0.9	11.3	0.7
Skim milk	2.9	5.2	0.3

315. A **Ration** is the amount of feed given to an animal during 24 hrs.

316. A **Balanced Ration** is one which contains the different nutrients in such amounts as best to meet the needs of the animal being fed.

317. Scientists have formulated balanced rations or the nutritive requirements of the various kinds of farm animals at different stages of growth and when being fed for different purposes, calculated for 1000 lbs. live weight. These are known as **Feeding Standards**, and are used as guides in practical feeding in compounding rations.

318. The following table shows the amounts of digestible nutrients in feeding standards, calculated for 1000 lbs. live weight:

FEEDING STANDARDS

Kind of Animal	Digestible Nutrients		
	Protein	Carbohydrates	Fats
	Pounds	*Pounds*	*Pounds*
Fattening cattle (first period) . . .	2.5	15.0	0.5
Fattening cattle (second period) . .	3.0	14.5	0.7
Fattening cattle (third period) . .	2.7	15.0	0.7
Horse (heavy work)	2.5	13.3	0.8
Horse (light work)	1.5	9.5	0.4
Dairy cow (giving 16½ lbs. milk daily)	2.0	11.0	0.4
Dairy cow (giving 22 lbs. milk daily)	2.5	13.0	0.5
Fattening swine (first period) . . .	4.5	25.0	0.7
Fattening swine (second period) . .	4.0	24.0	0.5
Fattening swine (third period) . .	2.7	18.0	0.4
Growing cattle (6 to 12 mos. old) .	3.5	12.8	1.5
Growing swine (3 to 5 mos. old) . .	5.0	23.1	0.8

When feeds rich in protein are high in price, the amount of protein may be reduced 10% without injury to the ration.

319. How nearly will the following ration meet the "Feeding Standard" requirements of a dairy cow giving 22 lbs. of milk daily?

Ration No. 1. 35 lbs. corn silage, 8 lbs. cow-pea hay, 6 lbs. corn stover, 3 lbs. cotton-seed meal, 4 lbs. corn.

To find total protein in ration:

By reference to table on page 249 it is found that corn silage contains .9 per cent of digestible protein. If there is .9 per cent of protein in corn silage, there is .9 lb. in 100 lbs.; therefore, in 1 lb. of silage there is $.9 \div 100 = .009$ lb. If in 1 lb. of silage there is .009 lb. of protein, in 35 lbs. there is $35 \times .009 = .315$ lb. of protein.

Ration:

35 lbs. silage	$= 35 \times .009 =$	.315 lb.	protein
8 lbs. cow-pea hay	$= 8 \times .108 =$	.864 lb.	protein
6 lbs. corn stover	$= 6 \times .017 =$	.102 lb.	protein
3 lbs. cotton-seed meal	$= 3 \times .372 =$	1.116 lbs.	protein
4 lbs. corn	$= 4 \times .078 =$	.312 lb.	protein
	Total $=$	2.709 lbs.	protein

By reference to the table of feeding standards, page 250, it is found that a dairy cow giving 22 lbs. milk a day should receive 2.5 lbs. of protein. In the ration above we have found that she receives 2.709 lbs. The ration therefore contains .209 lb. more protein than is required.

To find total carbohydrates in ration:

By reference to table (page 249), it is found that corn silage contains 11.3 per cent of digestible carbohydrates. If there is 11.3 per cent of carbohydrates in corn silage, there are 11.3 lbs.

in 100 lbs.; therefore, in 1 lb. of silage there are $11.3 \div 100 = .113$ lb. of carbohydrates. If in 1 lb. of silage there is .113 lb. of carbohydrates, in 35 lbs. of silage there are $35 \times .113 = 3.995$ lbs. of carbohydrates.

35 lbs. silage	$= 35 \times .113 =$	3.995 lbs. carbohydrates
8 lbs. cow-pea hay	$= 8 \times .386 =$	3.088 lbs. carbohydrates
6 lbs. corn stover	$= 6 \times .324 =$	1.944 lbs. carbohydrates
3 lbs. cotton-seed meal	$= 3 \times .169 =$	.507 lb. carbohydrates
4 lbs. corn	$= 4 \times .667 =$	2.668 lbs. carbohydrates
	Total =	12.162 lbs. carbohydrates

By reference to the table of feeding standards (page 250), it is found that a dairy cow giving 22 lbs. of milk a day needs 13 lbs. of carbohydrates. In the ration above she receives 12.162 lbs. The ration therefore lacks .832 lb. of carbohydrates.

To find total fats in ration:

By reference to table, it is found that corn silage contains .7 per cent of digestible fats. If there is .7 per cent of fats in corn silage, there is .7 lb. in 100 lbs.; therefore, in 1 lb. of silage there is $.7 \div 100 = .007$ lb. of fats. If in 1 lb. of silage there is .007 lb. of fats, in 35 lbs. there is $35 \times .007 = .245$ lb. of fats.

35 lbs. silage	$= 35 \times .007 =$	.245 lb. fats
8 lbs. cow-pea hay	$= 8 \times .011 =$	.088 lb. fats
6 lbs. corn stover	$= 6 \times .007 =$	.042 lb. fats
3 lbs. cotton-seed meal	$= 3 \times .122 =$	.366 lb. fats
4 lbs. corn	$= 4 \times .043 =$	.172 lb. fats
	Total =	.913 lb. fats

By reference to table of feeding standards, it is found that a dairy cow giving 22 lbs. of milk a day needs .5 lb. of fats. In the ration above, there is .913 lb. of fats, or an excess of .413 lb.

In a similar manner the amounts of protein, carbohydrates, and fats in the different feeds in any ration may be computed.

320. TABLE SHOWING PRICES OF FEEDS

Feeds	Estimated Price	Local Price
Corn, per bu.	$ 0.49	
Oats, per bu.	0.37	
Wheat bran, per T.	18.00	
Wheat middlings, per T.	19.00	
Cotton-seed meal, per T.	30.00	
Timothy hay, per T.	12.00	
Red-clover hay, per T.	12.00	
Cow-pea hay, per T.	12.00	
Alfalfa hay, per T.	12.00	
Corn stover, per T.	5.00	
Corn silage, per T.	3.00	
Skim milk, per cwt.	0.20	

Pupils should ascertain local prices of such feeds as are used in their neighborhood, and complete column three.

EXERCISE 208. — WRITTEN

1. Wherein will the following ration fail, according to the feeding standard, in meeting the requirements of a dairy cow giving 16.5 lbs. milk a day?

Ration No. 2. 35 lbs. corn silage, 10 lbs. corn stover, 5 lbs. corn, 5 lbs. wheat bran.

2. Construct a ration from the feeds used in your locality (if given in the table) that will better meet the requirements of this cow, and calculate and compare the cost of this ration with the one given.

3. Wherein and how much will the following rations fail, according to the feeding standard, to meet the needs of a horse doing hard work?

Ration No. 3. 10 lbs. corn stover, 6 lbs. cow-pea hay, 11 lbs. corn, 2 lbs. cotton-seed meal.

Ration No. 4. 15 lbs. timothy hay, 14 lbs. corn.

Ration No. 5. 15 lbs. timothy hay, 16 lbs. oats.

Ration No. 6. 4 lbs. timothy hay, 10 lbs. alfalfa, 7 lbs. corn, 8 lbs. oats.

4. It is seen that ration No. 3 is much nearer the requirements of such a horse than ration No. 4. Which is cheaper?

5. Wherein will the following ration fail, according to the feeding standard, in meeting the needs of a horse doing light work?

Ration No. 7. 7 lbs. corn stover, 8 lbs. alfalfa hay, 6 lbs. corn.

6. If a draught horse weighing 1500 lbs. requires $37\frac{1}{2}\%$ more nutrients than one weighing 1000 lbs., what will be the weight of the different nutrients required daily by such a horse when doing hard work? (For nutritive requirements for a 1000-lb. horse, see table of feeding standards, page 250.)

7. Construct a ration that will approximate the needs of such a draught horse, and compare its cost with a similarly composed ration for a 1000-lb. horse.

8. Wherein will the following ration fail to meet the requirements of a fattening beef animal during the third portion of the feeding period?

Ration No. 8. 35 lbs. corn silage, 15 lbs. corn stover, 4.5 lbs. cotton-seed meal, 6 lbs. corn.

9. How nearly will the following meet his needs during the second part of the feeding period?

Ration No. 9. 15 lbs. corn stover, 10 lbs. clover hay, 4 lbs. cotton-seed meal, 8 lbs. corn.

10. Wherein will the following ration fail to meet his requirements during the first part of the feeding period?

Ration No. 10. 15 lbs. corn stover, 10 lbs. timothy hay, 13 lbs. corn.

11. Find the weights of the different nutrients that would be required daily by a beef animal weighing 750 lbs. for each of the three fattening periods, if the same amounts of nutrients are required for each 100-lb. live weight as for each 100 lbs. of a 1000-lb. animal.

12. If pigs during the second part of the fattening period require daily for 1000 lbs. live weight, 4 lbs. protein, 24 lbs. carbohydrates, and .5 lb. fats, wherein will the following ration fail to meet their needs?

Ration No. 11. 24 lbs. corn, 10 lbs. wheat middlings, 25 lbs. skim milk.

13. Wherein will 40 lbs. of corn fail to meet their requirements?

14. Wherein will 20 lbs. of corn, and 20 lbs. of wheat middlings fail to meet their requirements?

15. Ascertain the rations being fed to the various kinds of animals in your locality, and compare them with the feeding standards given in table, page 250. Compare cost at local prices.

16. Ascertain local prices of feeds and construct rations that will come near to the requirements of the feeding standards for each of the animals for which sample rations have been given. Compute cost of each.

PROFIT AND LOSS

EXERCISE 209.—ORAL

1. I bought a book for $1 and sold it for 10 % more than I paid. What was the selling price?

2. When 10 % is gained, what part is gained?

3. A grocer sold butter for 30 cts. a pound that cost 20 cts. What was his per cent of gain?

4. Damaged goods bought at $125 were sold for $100. What was the per cent of loss?

5. If $120 is the cost price and $16\frac{2}{3}$ % is the gain, what is the selling price?

321. The per cent of gain or loss in a business transaction is always reckoned on the **cost** or the **sum invested.**

322. A merchant buys goods for $125 and sells them for $110. Does he gain or lose by the transaction?

$$\$125 = \text{cost}$$
$$\$110 = \text{selling price}$$
$$\$125 - \$110 = \$15 \text{ loss}$$
$$\$15 \div \$125 = 12\,\% \text{ loss.}$$

EXERCISE 210.—WRITTEN

1. A crate of berries, worth $6.40, was delayed in shipping and was sold at a loss of 25 %. What was the loss on the crate.

2. A man bought a team for \$280 and sold it at 15 % profit. What did he gain?

3. A man bought merchandise for \$472, and in selling gained \$67. What was the per cent of gain?

4. A storekeeper bought goods for \$679.50 and sold them for \$665.00. What was the per cent of loss?

5. A quantity of dress goods sold for \$67 at a loss of 15 %. What did it cost?

6. A transaction nets $18\frac{1}{2}$ % profit. How much must be invested to gain \$650?

7. A steamboat sold for \$117,600, 12 % more than it cost. What did it cost?

FARM PROFITS

8. With wheat yielding 20 bus. to the acre at 75 cts. a bushel, the land, $66\frac{2}{3}$ A. at \$40 an acre, costing in rent 5 % of its value, and the cost of raising the crop amounting to \$6 an acre, what is the profit? What is the per cent of profit?

9. With potatoes yielding 200 bus. to the acre at 40 cts. a bushel, the land $12\frac{1}{2}$ A. at \$50, costing in rent 5 % of its value, and the cost of raising amounting to \$20 an acre, what is the profit? What is the per cent of profit?

10. With onions yielding 500 bus. at 50 cts. a bushel, the land 4 A. at \$100 an acre, costing in rent 5 % of its value, and the cost of raising amounting to \$100 an acre, what is the profit? What is the per cent of profit?

11. Suppose in problem 8 the crop weighs 4 T.; in problem 9, 40 T.; in problem 10, 50 T.; and the farm being 5 mis. from town, marketing costs $2.50 a ton. How much will the results in each of the last three problems be changed, if you consider cost of marketing?

12. Suppose wheat be raised under the conditions of problem 8, on land valued as that in problem 10, but with the yield increased 50 % above that in problem 8. What will be the profit or loss?

13. Suppose onions to be raised under the conditions of problem 10, on land valued as that of problem 8, with a production decreased 75 % below that of problem 10. What will be the profit or loss?

14. When well-sorted apples bring $2.00 a barrel and poorly sorted apples $1.50 a barrel, what will be the profit on sorting 13 bbls. of apples, if in sorting, 2 bbls. of culls worth $1.00 a barrel be taken out? Estimate the labor of sorting at 75 cts. What is the per cent of profit upon the investment? (Note that the expense of sorting is the only item of expense in the investment.)

15. Suppose there were no sale for the culls and they are wasted. What will then be the profit of sorting?

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16. If a miller buys wheat at 86 cts. a bushel and in grinding obtains 72 % of flour, what per cent profit does he make in selling flour at $5.85 a barrel (196 lbs.), if the cost of milling is $1.31 per barrel of flour and he gets $33\frac{1}{2}$ cts. for the by-products?

17. At what per cent above cost must I sell $\frac{3}{5}$ of a city lot so that I may retain $\frac{2}{5}$ of it for my own use, free of cost?

18. With a farm worth \$4000, buildings \$1000, teams and tools \$1000, and with total sales amounting to \$1500, allowing for use of the money 5 %, depreciation in team and tools 10 %, depreciation and repairs on buildings 5 %, taxes and insurance \$50, labor \$200, supplies \$200, what is the profit? What per cent is paid on the investment?

19. If by \$300 additional labor the total sales can be increased to \$2000, what is then the net profit? What the per cent of profit? What the net profit on the \$300 additional labor? What the per cent of profit on this?

20. If I sell $\frac{4}{5}$ of an article for the price which I paid for the whole article, what per cent have I gained?

21. A merchant marks his goods at 25 % above cost. At what per cent below the marked price must he sell to make $17\frac{1}{2}$ %?

22. At what price above cost must this merchant mark his goods so that after he has deducted 15 % from the marked price, he will still have remaining a profit of $12\frac{1}{2}$ %?

23. A buys an engine for \$125. He trades this for another piece of machinery, and receives in addition 20 % of the cost of the first in money. The second piece of machinery is sold for \$90. Has he gained or lost on his investment, and what per cent?

COMMISSION

EXERCISE 211.—ORAL

1. A trucker ships 100 baskets of lettuce at $3 a basket, and pays 8% to the commission merchant for selling. What does he pay for selling?

2. What are the net proceeds from the shipment?

3. A real estate agent receives 3% for collecting rents. If his collections amount to $500 in a month, what is his percentage?

323. A person who buys or sells goods, or transacts business for another, is called a **Commission Merchant, Agent,** or **Broker.**

324. The pay is usually reckoned at a certain per cent of the price, and is called a **Commission** or **Brokerage.**

325. The sum left after the commission and other expenses have been paid is called the **Net Proceeds.**

EXERCISE 212.—WRITTEN

1. What will be an agent's commission for collecting rents amounting to $675 at $2\frac{3}{4}$% commission?

2. If an agent charges $3\frac{1}{4}$% for handling supplies for an orphanage, and his commission amounts to $750, what was the amount of supplies purchased?

3. A man has \$1250.00 to invest with a land company. He pays his agent \$40.75 for making the investment. What was the rate charged by the agent?

4. A clerk in a city store receives a salary of \$1200 a year; in addition he receives a commission of 2% on all goods he sells. If he receives \$1500 for the year, what is the amount of his sales?

5. An agent receives \$67.84 commission on sales. At 5% what was the amount sold?

6. A lawyer collected a debt of \$96 at 18% commission. What did he receive?

7. What is the commission on 20 crates of eggs at \$4.50 a crate, commission 10%? On 250 T. of cabbages at \$3.30 a ton, commission 8%?

8. If a farmer ships 38 baskets of beans to a commission merchant in Baltimore, who sells them for \$1.25 a basket, how much money should the farmer receive if the merchant charges 8% commission for selling, and pays 40 cts. freight per basket?

9. A strawberry grower ships 27 crates of strawberries to a commission merchant in New York City, who sells them for \$3.25 a crate. After deducting his commission, paying drayage of 3 cts. a crate, and refrigerator car charges of 75 cts. a crate, he remits \$59.67 to the grower. What per cent commission did he charge?

10. A farmer ships 34 crates of cabbages to a commission merchant in Philadelphia, who sells them for \$1.50 a crate. How much should the merchant send the farmer after deducting $8\frac{1}{2}$% commission, paying drayage charges of 5 cts. a crate and freight charges of 50 cts. a crate?

11. A live-stock dealer ships a car-load of 27 cattle weighing 1437 lbs. each to Chicago, and the commission man sells them for $5.75 per cwt. After paying $1.00 switching charges on the car, $5.00 yardage, 600 lbs. hay at $10.00 a ton, 400 lbs. corn at 50 cts. a bushel (1 bu. = 56 lbs.), $59.00 freight, and charging 50 cts. a head for selling, what will be the amount of net proceeds sent to the shipper?

12. What per cent of the gross receipts are the total charges connected with selling the cattle in problem 11?

13. If this same car-load of cattle had been shipped to Richmond, Va., and the freight charges and selling price had been the same, what would have been the net proceeds returned to the shipper, if the other charges had been as follows? Commission for selling 4%, 600 lbs. hay at $20 per ton, 400 lbs. corn at $1 a bushel, yardage $10.

14. What per cent on gross receipts are the charges connected with selling the cattle in problem 13?

15. If a grower ships 27 bbls. of potatoes to a commission merchant in Philadelphia, who sells them for $2.75 a barrel, pays 50 cts. a barrel freight, 5 cts. a barrel drayage, and remits $53.46 to the grower, what per cent commission did the agent charge for selling?

16. A publisher sells at auction for various customers rare books which bring respectively: $125.50, $62.25, $187.50, $285.00, $845.25, $35.50, $48.75, $88.00, $672.00, and $950.50. If he charges 8% commission, what does he receive for the transaction?

COMMERCIAL DISCOUNT

EXERCISE 213.—ORAL

1. If a merchant buys a bill of goods marked $500 and receives 10% reduction for paying cash, what does he pay?

2. A school history costs 50 cts. If 25% is allowed for an old text-book taken in exchange, how much cash is paid for the new history?

3. If a grocer allows 10% from his bill for cash, what amount will he deduct from a bill of $25?

326. A deduction from the price or value of anything is called a **Commercial Discount.**

Manufacturers and dealers in merchandise often issue a **Price List** from which certain discounts are allowed.

327. Prices published in catalogues known as **List Prices** are often subject to discounts.

328. Sometimes several discounts are allowed to the buyer. In cases of this kind the first discount is to be deducted, then the second computed upon the remainder and deducted, and so on for each discount; *e.g.*, when 40%, 10%, and 5% discounts are allowed from a bill of goods, the 40% is first deducted, then 10% from the remainder, and then 5% is deducted from the last remainder. The amount remaining after deducting the discounts is the **Net Price** or **Net Amount.**

EXERCISE 214.—WRITTEN

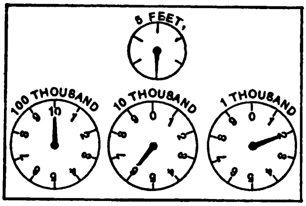
1. A chemist buys a bill of laboratory supplies from A. H. Newsom & Co., New York. He is allowed 50% and 10% discount from list price and 5% off for cash. What is the discount on an original bill of $350?

2. Mr. A's grocery bill for the month was $34.75; his cash discount was $2.78. What per cent of discount was allowed for cash?

3. A discount of 10% is offered on all purchases during a certain season and 5% additional for cash. What is the discount on a bill of $249.60? On $678.00?

4. The bill of a certain gas company reads:

"The following discount will be allowed if this bill is paid at the office of the company on or before the fifteenth instant:



100 to 2000 cubic feet, monthly, $1.25 per 1000 feet.

Over 2000 to 5000 cubic feet, monthly, $1.25 per 1000 feet less 5%.

Over 5000 to 10,000 cubic feet, monthly, $1.25 per 1000 feet less 10%.

Over 10,000 to 15,000 cubic feet, monthly, $1.25 per 1000 feet less 15%.

Over 15,000 to 20,000 cubic. feet, monthly, $1.25 per 1000 feet less 20%.

20,000 cubic feet or over, monthly, light and fuel, $1.25 per 1000 feet less 25%."

What is the net cost of the following amounts of gas:

1990 cu. ft.? 2100 cu. ft.? 3500 cu. ft.? 4900 cu. ft.? 5100 cu. ft.? 9000 cu. ft.? 9900 cu. ft.? 10,000 cu. ft.?

INSURANCE

EXERCISE 215.—ORAL

1. What will be the cost of insuring a building worth $6000 for $\frac{2}{3}$ its value at 40 cts. on a hundred dollars?

2. A merchant insures his store valued at $5000 for $\frac{3}{4}$ its value at 1%. What does it cost him?

3. I pay $96 annually for a life insurance of $4000. What is the rate per thousand?

329. **Insurance** is the promise of indemnity for personal and property losses.

330. Insurance is of two kinds—**Property**: fire, hail, tornado, etc.; **Personal**: life, accident, health.

331. The written contract between the insurance company and the person insured is called the **Policy**.

332. The **Premium** is the sum paid for the insurance.

EXERCISE 216.—WRITTEN

LIFE INSURANCE

1. What is the premium on a $4000 policy at $28 per $1000?

2. If a $1000 policy of life insurance costs the insured $32.16 each year, what will be the total cost of a $4000 policy for 20 yrs.?

The rates per $1000 on a policy in a certain company are: at 20 yrs. of age, $14.96; at 30, $19.06; at 40, $26.07; at 50, $38.92; at 60, $63.42.

3. What would be the cost of a $4000 policy per year if taken at 20 yrs. of age? What if taken at each of the other years given?

4. If taken at 20 yrs., what would be the total cost if carried 20 yrs.? What would it be if taken at each of the other ages and carried for 20 yrs.?

5. What is the difference in premiums, per thousand, between a policy for a man of 20 yrs. and a policy for a man of 40? Of 60?

6. A participating 20-yr. endowment policy is one which pays the insured the face of the policy at the end of 20 yrs., and in addition thereto profits or dividends. If this policy costs $48.10 each year and the profit at the end of the 20 yrs. is $316.00, what per cent of the total premiums is this profit?

PROPERTY INSURANCE

7. Insurance on a shingle-roofed dwelling with a water supply and fire protection costing 50 cts. on $100 for one year, what is the cost of insurance to the amount of $4500?

8. If it costs twice as much to carry the insurance 3 yrs. as it does to carry it 1 yr., what will be the cost per year in the last problem if the owner insures for a period of 3 yrs.?

9. If it costs three times as much to insure for a term of 5 yrs. as for 1 yr., what is the rate per year in problem 7 if taken for a term of 5 yrs.?

10. Each dwelling within 30 ft. adds 15 cts. per $100 to the cost of insurance. What will the insurance in problem 7 cost if there is a building 29 ft. 6 ins. to the right of this dwelling and another 32 ft. to the left? What will it be if there is a dwelling 30 ft. to the right and another 30 ft. to the left?

11. Suppose the dwelling of problem 7 were slate instead of shingle roof. The rate then might be 40 cts. per $100. How much less would the insurance be?

12. Suppose the dwelling instead of being in a city well protected from fire were in a city with no fire protection, the rate might then be 75 cts. per $100 under the conditions of problem 7. What would be the cost per year?

13. The rates on certain classes of unprotected property are very high. Saw-mills sometimes cost 14% yearly. What would be the premium for 1 yr. on a $3500 saw-mill insured for $\frac{3}{4}$ value?

14. What per cent of the face of the policy is the yearly premium in problem 7?

15. The insurance rate in the country being 1%, what is the premium on the insurance of a barn with contents valued at $2700, if the property is insured for $\frac{3}{4}$ of its value?

16. What is the premium on a country dwelling valued at $6400 at the same rate, if the property is insured for $\frac{2}{3}$ of its value?

17. The rate being $\frac{3}{4}$%, or 75 cts., on the hundred, if the buildings are metal roofed, what is then the premium in problem 16?

TAXES

EXERCISE 217.—ORAL

1. If a man pays annually for public purposes 2% of the value of his property, which is \$7000, what amount does he pay?

2. Mr. A pays for public purposes 2% on his real estate, valued at \$4000, $2\frac{1}{2}$% on money in bank, which is \$1000. What amount does he pay for public purposes?

3. If a man pays annually \$200 upon real estate for public purposes, which is 2% of its value, what is the value of his property?

333. **Taxes** are required from individuals for the support of the government and for other public purposes.

334. Land, buildings, and other fixed property is called **Real Estate.**

335. Movable property, as household goods, clothing, jewelry, mortgages, live-stock, machinery, etc., is **Personal Property.**

336. The valuation of property for taxation is made by **Assessors,** or **Tax Listers.** Taxes are levied at a certain rate or per cent on the assessed valuation of the property.

337. A **Tax Collector** is an officer who collects the taxes. He usually receives a percentage of the taxes collected.

EXERCISE 218. — WRITTEN

1. A farm valued at $6750 near a city is assessed at $\frac{3}{4}$ its value. The tax rate being .7 %, what are the taxes?

2. The city boundary is extended so as to include one-half of this farm. The city tax rate being 2.49 %, what is the increase in taxes?

3. A man owning $4200 worth of personal property, living in the city, pays what taxes at the above rate?

4. With the same property what are his taxes if outside the city limits?

5. An income tax of 1 % on all annual incomes over $1000 is collected in some states. What is the income tax of a man receiving a salary of $1200? Of $2400? Of $3500? What is it if his salary be $2400 and he earns $250 additional by extra labor?

6. The rate being .6 %, what are the taxes on 160 A. of timber land assessed at $9.38 per acre? At $16.88? At $24.38? At $31.88?

7. If a man owns $8700 worth of property valued for taxes at $\frac{2}{3}$, and the rate for state and county taxes is 1.05 %, the city or local rate is 1.25 %, poll tax is $2.00, and he has an income of $2700, on which he pays an income tax of 1 % on all over $1000, what will be his taxes?

8. If a school district having an assessed property valuation of $200,000, maintains a public school 7 mos. at a cost of $720, and could maintain it 2 mos. more at an additional cost of $180, what will be the increase in the taxes of a man owning property valued for taxation

at $2600, if a special tax is voted for maintaining the school 2 additional months?

9. A man owns property in the city worth $9750. The valuation for taxation is $\frac{2}{3}$ and the rate 2.15%. He receives $776 rent for this property.

He also owns farm property of the same value, which is valued the same for taxes, but the rate is .9%. The rent obtained for this property is $682.50. On which does he receive the larger net profit, and how much more?

10. If a state having an assessed valuation of $393,571,982 increases its appropriation for the support of its Agricultural College from $100,000 to $150,000 per year, what will be the increase in taxes of a man who owns property valued for taxes at $3500?

11. If the assessed valuation of the property in a county is $14,844,364 and the total state and county taxes amount to $185,554.55, what is the tax rate, stated in per cent and as mills on the dollar?

12. If the assessed valuation of the property in a county is $15,452,776 and the total state and county taxes collected amount to $245,931.64, what is the rate of taxation if there be 7552 polls on which there is a tax of $1.87 each?

DUTIES OR CUSTOMS

338. A charge is fixed by the government upon goods imported from other countries. Such charges are called **Duties.**

339. When the duty is a certain per cent of the cost of the goods, it is called an **Ad Valorem Duty.**

340. When the duty is fixed without regard to the value of the goods, it is called a **Specific Duty.**

341. This table gives the customs duties according to the Tariff Act of 1897 on several articles imported into the United States:

Apples, 25 cts. per bu.
Barley, 30 cts. per bu.
Beef, 2 cts. per lb.
Bottled beer, 40 cts. per gal.
Bonnets, 60% ad val.
Books, 25% ad val.
Books for public libraries, free.
Cheese, 6 cts. per lb.
Cigars, $4.50 per lb. and 25% ad val.

Coffee, free.
Diamonds, 60% ad val.
Eggs, 5 cts. per doz.
Hay, $4 per ton.
Horses, $30 per head.
Jewelry, 60% ad val.
Potatoes, 25 cts. per bu.
Wool, 11 cts. per lb.
Woolen clothing 40 cts. per lb. and 60% ad val.

EXERCISE 219. — WRITTEN

1. What is the duty on 360 lbs. of cheese?

2. What is the duty on 400 lbs. of cheese costing 8 cts. per pound?

3. What is the duty on $2000 worth of diamonds?

4. What is the duty on a consignment of 3 head of horses valued at $350 each?

5. What is the duty on a car-load of 9 T. of hay worth $8 a ton?

6. What is the duty on 4 lbs. of cigars valued at $4 a pound?

7. What is the duty on 4 lbs. of cigars valued at $8 a pound?

8. Pupils should make ten similar problems concerning the articles given in the table that are used in their homes.

342. COMPOSITION OF FOODS

Foods	Refuse	Water	Protein	Fat	Carbo-hydrates	Ash
	Per Cent	*Per Cent*	*Per Cent*	*Per Cent*	*Per Cent*	*Per Cent*
Beef flank	5.5	56.1	18.6	19.9		0.8
Salt pork		7.9	1.9	86.2		3.9
Pickled tongue	6	58.9	11.9	19.2		4.3
Bacon	8.7	18.4	9.5	59.4		4.5
Veal cutlet	3.4	68.3	20.1	7.5		1
Fish	44.7	40.4	10.2	4.2		0.7
Chicken	25.9	47.1	13.7	12.3		0.7
Ham	12.2	35.8	14.5	33.2		4.2
Milk		87	3.3	4	5	0.7
Cheese		34.2	25.9	33.7	2.4	3.8
Butter		11	1	85		3
Eggs	11.2	65.5	13.1	9.3		0.9
Flour		12	11.4	1	75.1	0.5
Oatmeal		7.3	16.1	7.2	67.5	1.9
Corn meal		12.5	9.2	1.9	75.4	1
Apples	25	63.3	0.3	0.3	10.8	0.3
Bananas	35	48.9	0.8	0.4	14.3	0.6
Bread		35.3	9.2	1.3	53.1	1.1
Sugar					100	
Potatoes	20	62.6	1.8	0.1	14.7	0.8
Cabbage	15	77.7	1.4	0.2	4.8	0.9
Lettuce	15	80.5	1	0.2	2.5	0.8
Peas		74.6	7	0.5	16.9	1
String beans	7	83	2.1	0.3	6.9	0.7
Turnips	30	62.7	0.9	0.1	5.7	0.6
Squash	50	44.2	0.7	0.2	4.5	0.4
Dried beans		12.6	22.5	1.8	59.6	3.5
Canned tomatoes		94	1.2	0.2	4	0.6
Rice		12.3	8	0.3	79	0.4
Sweet potatoes	20	55.2	1.4	0.6	21.9	0.9
Plain cake		19.9	6.3	9	63.3	1.5

343. TABLE OF DIGESTIBILITY OF FOODS

	PROTEIN	FATS	CARBO-HYDRATES
	Per Cent	*Per Cent*	*Per Cent*
Meats and fish	97	95	98
Eggs	97	95	98
Dairy products	97	95	98
Cereals	85	90	98
Sugars			98
Dried peas and beans	78	90	97
Vegetables	83	90	95
Fruits	85	90	90

EXERCISE 220. — WRITTEN

1. The human body is composed of: ash 6%, protein 18%, fats 15%, carbohydrates about 1%. The remainder is water. A man weighing 150 lbs. has how many pounds of water in his body tissues?

2. A man weighing 150 lbs. has how many pounds of fat? The fat equals what per cent of the water?

3. A man weighing 150 lbs. has how many pounds of protein? The fat equals what per cent of the protein?

4. The carbohydrates equal what per cent of the protein?

5. Since 97% of the protein of meat and fish is digestible, how many ounces are digestible in 2 lbs. of beef flank?

6. Since 95% of the fats of meat and fish is digestible, how many ounces are digestible in 1 lb. of fish?

7. Since 98% of the carbohydrates of meat and fish is digestible, how many ounces are digestible in 3 lbs. of veal?

Find the number of ounces of water, refuse, and digestible protein, fats, and carbohydrates in the following:

8. 1 lb. of bread. **9.** 1 lb. of chicken. **10.** 1 lb. of milk. **11.** 1 lb. of corn bread. **12.** 1 lb. of potatoes. **13.** 1 lb. of cabbage. **14.** 1 lb. of turnips. **15.** 1 lb. of ham. **16.** 1 lb. of rice. **17.** 1 lb. of apples. **18.** 1 lb. of cheese.

The following food materials were consumed in one day by a family of four grown persons, two men and two women, at moderately hard work:

Food Materials	Pounds	Ounces	Food Materials	Pounds	Ounces
BREAKFAST			DINNER		
Oatmeal		8	Butter		2
Milk		6	Rice pudding:		
Sugar		3	Rice		4
Veal cutlet . . .		8	Eggs		4
Bread		8	Milk		6
Butter		2	Sugar		3
Coffee		0	Tea		0
DINNER			SUPPER		
Roast beef (flank) .	1	12	Bread		12
Potatoes	1		Butter		3
Sweet potatoes . .		12	Bananas		12
Bread		6	Cake		8

19. Find the amount of digestible protein, carbohydrates, and fats per person in the three meals.

20. Estimating 453.6 grams to a pound, compare with food standards, as follows: man requiring protein 100 grams, carbohydrates 400 grams, fats 60 grams; woman requiring protein 90 grams, carbohydrates 350 grams, fats 40 grams. Wherein is the ration excessive? Wherein deficient?

INTEREST

What per cent of 100 is 6?

What per cent of $1 is 6 cts.?

If $6 is charged for the use of $100, what per cent of the sum loaned is the sum charged?

344. The money charged for the use of money is called **Interest.**

345. The money loaned is called the **Principal.**

346. The per cent which the interest is of the principal is the **Rate of Interest.**

347. The principal plus the interest is called the **Amount.**

348. Many states have established a fixed rate of interest, an excess of which it is unlawful to accept. This fixed rate is known as the **Legal Rate** of interest.

349. Usury is interest charged in excess of that allowed by law, or the legal rate.

350. Interest is usually calculated by taking a certain rate per cent of the principal for one year.

351. The time for which interest is to be reckoned is calculated in years and days. When over a year, both years and days are used, and when under a year, days

only. In both cases the exact number of days is counted, if **exact interest** is desired.

352. In practice, however, when money is loaned for less than a year **interest is usually reckoned** on a basis of 30 days to the month, and 12 months, or 360 days, to the year, instead of 365 days as when exact interest is computed.

If \$500 is loaned from May 1, 1906, to Aug. 1, 1907, the exact time is 1 year and 92 days, but in business, interest is usually reckoned for 1 year and 3 months, or $1\frac{1}{4}$ years, instead of for $1\frac{92}{365}$ years. The United States government and some banks, however, use the exact method, and in the above example would reckon interest for $1\frac{92}{365}$ years.

353. When money is loaned for a certain number of months, or when interest is payable monthly, **calendar months** are meant.

EXERCISE 221. — ORAL

Find the interest on the following sums for the times and rates specified:

1. \$5 for 1 year at 4 %; at 5 %; at 6 %.
2. \$25 for 1 year at 3 %; at 6 %; at 8 %.
3. \$50 for 1 year at 4 %; at 6 %; at 7 %.
4. \$300 for 2 years at 4 %; at 7 %; at 9 %.
5. \$600 for 1 year and 6 months at 4 %; at 6 %.
6. \$800 for 1 year and 3 months at 6 %; at 8 %.
7. \$400 for 2 years at 6 %; at 8 %; for 2 years and 3 months at 8 %; at 10 %.

8. \$1200 for 1 year at 8 %; for 3 years at 7 %; for 6 months at 9 %; for 3 months at 5 %.

354. Find the interest on \$375.25 at 6 % for 2 years.

The interest for 1 year is 6 % of 375.25, or $375.25 \times .06 = 22.515 = \$22.515$.

For 2 years the interest is $\$22.515 \times 2 = \$45.03$.

Find the interest on \$450 for 3 years, 4 months, and 15 days at 8 % per year?

The interest for 1 year is $450 \times .08 = 36.00 = \$36.00$	
The interest for 3 years is $\$36 \times 3 =$	\$108.00
The interest for 4 months is $\frac{4}{12}$, or $\frac{1}{3}$, of \$36 =	12.00
The interest for 15 days is $\frac{15}{30}$, or $\frac{1}{2}$, of $\frac{1}{12} = \frac{1}{24}$ of \$36 =	1.50
Therefore, the total interest is	\$121.50

355. To find the interest for a given time, find the interest for 1 year and multiply by the number of years or fraction of a year.

EXERCISE 222. — WRITTEN

Find the interest and amount:

1. \$275.25 for 1 yr. 3 mos. 20 days at 8 %.
2. \$345 for 2 yrs. 6 mos. 15 days at 6 %.
3. \$435 for 3 yrs. 11 mos. at 5 %.
4. \$850 for 1 yr. 8 mos. 15 days at $5\frac{1}{2}$ %.
5. \$340 from June 1, 1906, to Sept. 15, 1908, at 6 %.
6. \$450 from Sept. 10, 1905, to Dec. 25, 1907, at 8 %.
7. \$815.27 from Jan. 10, 1905, to Oct. 1, 1908, at 10 %.
8. \$427.25 from Nov. 5, 1906, to Jan. 20, 1908, at 6 %.
9. \$650 from April 10, 1908, to Oct. 10, 1908, at 4 %.
10. \$347.50 from Feb. 5, 1908, to Sept. 10, 1908, at 6 %.

EXERCISE 223. — WRITTEN

Find the exact interest on :

1. $200 from July 1, 1905, to Aug. 7, 1907, at 6 %.
2. $450 from July 3, 1907, to May 31, 1908, at 8 %.
3. $775 from Dec. 9, 1905, to Feb. 17, 1908, at 6 %.
4. $2550 from May 21, 1907, to Dec. 13, 1907, at $4\frac{1}{2}$ %.
5. $90 from Aug. 10, 1906, to Nov. 10, 1906, at 7 %.
6. $1750 from Jan. 24, 1906, to Feb. 16, 1907, at 5 %.
7. $335 from July 1, 1900, to June 19, 1903, at 6 %.
8. $3750.50 from Jan. 29, 1899, to Feb. 29, 1908, at 6 %.

356. For convenience in finding the correct or exact time, the following table is frequently used by bankers and others :

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
January . .	365	31	59	90	120	151	181	212	243	273	304	334
February .	334	365	28	59	89	120	150	181	212	242	273	303
March . .	306	337	365	31	61	92	122	153	184	214	245	275
April . . .	275	306	334	365	30	61	91	122	153	183	214	244
May . . .	245	276	304	335	365	31	61	92	123	153	184	214
June . . .	214	245	273	304	334	365	30	61	92	122	153	183
July . . .	184	215	243	274	304	335	365	31	62	92	123	153
August . .	153	184	212	243	273	304	334	365	31	61	92	122
September .	122	153	181	212	242	273	303	334	365	30	61	91
October . .	92	123	151	182	212	243	273	304	335	365	31	61
November .	61	92	120	151	181	212	242	273	304	334	365	30
December .	31	62	90	121	151	182	212	243	274	304	335	365

The exact number of days from any particular day of any month to the corresponding day of any other month, within 1 year, is found opposite the first month and under the second. If the day of the month is not the same in the two months,

the difference may be added or subtracted as the case may require, *e.g.*, from July 10, to Dec. 10 is 153 days. From July 10 to Dec. 23 is $153 + 13 = 166$ days. From July 31 to Dec. 20 is $153 - 11$ days $= 142$ days.

357. On many calendars used in business offices the days of the years are numbered consecutively through the months, and in calculating interest for periods less than a year, business men frequently take the number of the day on which interest begins and subtract it from the number of the day when it is due; *e.g.*, June 18, 1908, is the 170th day of the year, and Nov. 12 is the 317th day, therefore from June 18 to Nov. 12 is $317 - 170 = 147$ days.

SIX PER CENT METHOD

358. What is the interest on \$1 at 6 % for 1 month? For one day?

If the interest on \$1 for 12 mos. is \$.06, the interest on \$1 for 1 mo. is $\frac{1}{12}$ of \$.06 = \$.005, and the interest on \$1 for 1 da. is $\frac{1}{30}$ of \$.005 = \$.000$\frac{1}{6}$.

Thus:

The interest on \$1 for 1 yr. at 6 % = \$.06.
The interest on \$1 for 1 mo. at 6 % = \$.005.
The interest on \$1 for 1 da. at 6 % = \$.000$\frac{1}{6}$.

What is the interest on \$360.40 at 6 % for 2 yrs. 8 mos. 18 days?

The interest on \$1 for 2 yrs. is \$.06 × 2 = \$.12
The interest on \$1 for 8 mos. is \$.005 × 8 = .04
The interest on \$1 for 18 days is \$.000$\frac{1}{6}$ × 18 = .003
The interest on \$1 for 2 yrs. 8 mos. 18 days = \$.163

The interest on \$360.40 for 2 yrs. 8 mos. 18 days = \$360.40 × .163 = \$58.7452, or \$58.75.

359. To find the interest on any sum at 6% for a given number of years, months, and days, multiply 6 cts. by the number of years; .5 cts. by the number of months; and $\frac{1}{6}$ of a mill by the number of days. Find the sum of these and multiply this sum by the principal.

EXERCISE 224. – WRITTEN

Find the interest by the six per cent method on:

1. \$475.40 for 1 yr. 2 mos. 6 days, at 6%.
2. \$820 from June 1, 1904, to Oct. 12, 1905, at 6%.
3. \$528.60 for 3 yrs. 8 mos. 18 days at 6%.
4. \$360.50 for 3 yrs. 9 mos. 24 days at 6%.
5. \$750 from May 12, 1901, to April 18, 1903, at 6%.

360. Short-time loans are frequently made for 3, 4, 6, 8, or more months:

Since the interest on \$1 for 1 mo. at 6% is \$.005, or $\frac{1}{2}$ ct., to find the interest on any sum at 6% for time expressed in months, move the decimal point two places to the left in the principal and multiply by one-half the number of months.

The interest on \$320.50 for 6 mos. is $3.205 \times 3 = 9.615$ $= \$9.615$.

361. Loans made for three months or less are usually made for 30, 60, or 90 days:

Since the interest on \$1 for 1 da. at 6% is $\frac{1}{6}$ of a mill, to find the interest on any sum for time expressed in days, move the decimal point three places to the left in the principal and multiply by $\frac{1}{6}$ the number of days.

The interest on \$160.75 for 30 days is $.16075 \times \frac{1}{6}$ of 30 $= .16075 \times 5 = .80375 =$ \$.80375, or 80 cts.

EXERCISE 225. — WRITTEN

Find the interest at 6 % on:

1. \$325 for 8 mos.
2. \$785 for 6 mos.
3. \$957 for 9 mos.
4. \$2450 for 7 mos.
5. \$375 for 11 mos.
6. \$945 for 30 days.
7. \$1500 for 60 days.
8. \$525 for 90 days.
9. \$343 for 30 days.
10. \$250 for 90 days.

362. The six per cent method may be used for finding the interest at other rates, as follows:

2 % is $\frac{2}{6}$, or $\frac{1}{3}$, of 6 %, therefore, take $\frac{1}{3}$ of the interest at 6 %.
3 % is $\frac{3}{6}$, or $\frac{1}{2}$, of 6 %, therefore, take $\frac{1}{2}$ of the interest at 6 %.
4 % is $\frac{4}{6}$, or $\frac{2}{3}$, of 6 %, therefore, take $\frac{2}{3}$ of the interest at 6 %.

$4\frac{1}{2}$ % is $\frac{4\frac{1}{2}}{6}$, or $\frac{3}{4}$ of 6 %, therefore, take $\frac{3}{4}$ of the interest at 6 %, or subtract $\frac{1}{4}$ of the interest at 6 %.

5 % is $\frac{5}{6}$ of 6 %, therefore, take $\frac{5}{6}$ of the interest at 6 %, or subtract $\frac{1}{6}$ of the interest at 6 %.

7 % is $\frac{7}{6}$ of 6 %, therefore, take $\frac{7}{6}$ of the interest at 6 %, or add $\frac{1}{6}$ of the interest at 6 %.

$7\frac{1}{2}$ % is $\frac{7\frac{1}{2}}{6}$, or $\frac{5}{4}$ of 6 %, therefore, take $\frac{5}{4}$ of the interest at 6 %, or add $\frac{1}{4}$ of the interest at 6 %.

363. The six per cent method being based on 12 months, or 360 days, to the year, of course, does not find the exact interest.

EXERCISE 226. — WRITTEN

Find the interest by the six per cent method on:

1. \$ 250 for 1 yr. 3 mos. at 2 %.

2. \$335 from July 10, 1903, to June 20, 1905, at 3 %.
3. \$945 for 2 yrs. 4 mos. 20 days at 4 %.
4. \$1350 from Dec. 12, 1905, to Feb. 1, 1907, at $4\frac{1}{2}$ %.
5. \$725 for 1 yr. 7 mos. 13 days at 5 %.
6. \$2450 from Aug. 15, 1905, to Nov. 20, 1908, at 7 %.
7. \$133 for 2 yrs. 5 mos. 23 days at $7\frac{1}{2}$ %.
8. \$420 from July 20, 1898, to June 5, 1901, at 8 %.

364. It is seen that in computing interest there are four factors involved: time, rate per cent, principal and interest, or principal and amount, or interest and amount.

Any one of these factors can be found if the other three be given, but in business the principal, rate per cent, and time are usually given and the interest, or interest and amount, are required to be found.

365. It may be necessary to find the principal, rate, or time when only two of these and the interest, or the amount, are given.

366. To find the principal, when the rate, time, and interest or amount are given:

What principal will produce \$15 interest in 2 yrs. 6 mos. at 6 %?

Interest on \$1 for 1 yr. at 6 % = \$.06.
Interest on \$1 for $2\frac{1}{2}$ yrs. at 6 % = $\$.06 \times 2\frac{1}{2} = \$.15$

Hence, principal required $= \dfrac{\$15}{.15} = \$100.$

What principal at 6 % interest for 2 yrs. 6 mos. will amount to \$115?

A principal of \$1 at 6 % for 1 yr. = \$.06 interest.

A principal of $1 at 6 % for $2\frac{1}{2}$ yrs. = $\$.06 \times 2\frac{1}{2} = \$.15$ interest.

A principal of $1 at 6 % interest for $2\frac{1}{2}$ yrs. amounts to principal $1 + interest $.15 = $1.15.

Hence, principal required $= \frac{\$115}{\$1.15} = \$100.$

EXERCISE 227. — WRITTEN

Find the principal that will bring:

1. $450 interest in 3 yrs. at 6 %.
2. $72.74 interest in 3 yrs. 9 mos. at $2\frac{1}{2}$ %.
3. $11.33 interest from July 5, 1904, to Feb. 9, 1905, at 4 %.
4. $18.72 interest in 5 mos. 27 days at $5\frac{1}{4}$ %.

EXERCISE 228. — WRITTEN

Find the principal that will amount to:

1. $1283.33 at 5 % interest for 3 yrs. 4 mos.
2. $1303.41 at 6 % interest for 60 days.
3. $25.76 at 6 % interest for 33 days.
4. $94.31 at 6 % interest for 1 yr. 7 mos. 21 days.

367. To find the rate per cent, when the time, principal, and the interest or the amount are given:

At what rate per cent will $100.00 produce $24.50 interest in 3 yrs. 6 mos.?

The interest on $1 for 1 yr. at 1 % = $.01.
The interest on $1 for $3\frac{1}{2}$ yrs. at 1 % = $.035.
The interest on $100 for $3\frac{1}{2}$ yrs. at 1 % = $3.50.

Hence, the rate is $\frac{\$24.50}{3.50} = 7\ \%.$

EXERCISE 229.—WRITTEN

Find the rate per cent:

1. When the interest on \$2300 for 1 yr. is \$138.

2. When the interest on \$675.88 for 5 yrs. is \$118.28.

3. When \$6130 at interest from June 6 to Nov. 24 amounts to \$6237.28.

4. When \$1050 at interest from Sept. 21, 1904, to March 5, 1905, amounts to \$1069.15.

368. To find the time, when the rate, principal, and the interest or the amount are given:

In what time will \$100, at 6%, bring \$21 interest?

The interest on \$1 at 6% for 1 yr. = \$.06. The interest on \$1 for the unknown time = \$21 ÷ 100 = \$.21.

Hence, the unknown time $= \frac{\$.21}{.06} = 3\frac{1}{2}$ yrs.

EXERCISE 230.—WRITTEN

Find the time in which:

1. The interest on \$1500 will be \$180 at 4%.

2. The interest on \$8520 will be \$1746.60 at 6%.

3. The interest on \$17,040 will be \$3493.20 at 6%.

4. \$238.74 at $4\frac{1}{2}$% will amount to \$303.20.

369. In the foregoing solutions the unit in finding the principal was \$1; the unit in finding the time was 1 year, and in finding the rate the unit was 1 per cent. Hence, to find the principal, time, or rate, when the other factors are given, divide the given interest by the interest obtained by using the unit as the required factor.

STOCKS AND BONDS

370. When two or more persons form an organization under the laws of the state to conduct business as one body, the organization is called a **Company, Stock Company**, or **Corporation.**

371. The money contributed for the purpose of carrying on the business of a company is known as its **Capital, Capital Stock**, or **Stock.**

372. The stock of a company is divided into a number of equal parts known as **Shares**, or **Shares of Stock.**

373. A person holding or owning one or more shares of stock is known as a **Stockholder.**

374. The document or certificate issued to each stockholder showing the number of shares he owns, is called a **Certificate of Stock.**

375. A **Bond** is a written promise or obligation of a corporation, or a government, to pay a specified sum of money at a certain time, with interest at regular stated intervals and at a certain rate.

376. The original, certificate, or face value of a stock is its **Par Value.** The price for which it sells is its **Market Value.** When the market value is greater than its par value, the stock is said to be at a **premium**, and when it

sells for less than the face or par value, it is at a **Discount** or **Below Par.**

377. The profits of a company which are divided among the stockholders according to the stock which they hold are known as the **Dividends.**

378. The capital stock of a corporation is sometimes divided into two kinds: **Preferred** and **Common.** A dividend is usually guaranteed on the preferred stock, and in such case must be paid before any dividend is paid on the common stock.

379. Persons who buy and sell stocks and bonds are called **Stock Brokers,** or **Brokers,** and their commission is called **Brokerage.** Brokerage is computed on the par value of the stock.

380. Small certificates of interest, called **Coupons,** are usually attached to bonds. These coupons are promises to pay interest at a certain time at a specified rate. If this interest is not paid when due, the interest itself draws interest at the legal rate.

381. Large numbers of different stocks and bonds are regularly on the market, and are bought and sold extensively. The following are a few with the quotations given in a daily newspaper June 27, 1908:

The figures indicate the price in dollars per share or bond. The par value is usually $100, but in some cases it may be $50, or some other value. In the following problems $100 is the par value of the stocks or bonds in question, unless otherwise stated:

Stocks		Bonds	
L. & N.	$103\frac{1}{2}$	U. S. 4's	$121\frac{1}{4}$
Am. Copper . . .	$66\frac{3}{8}$	Minn. & St. L. 4's .	76
B. & O.	86	Mo. K. & Tex. . .	$96\frac{1}{2}$
Ch. & N. W.	150	B. & O. 4's	$98\frac{1}{2}$
Ill. Cent.	$130\frac{7}{8}$	Col. Mid. 4's . . .	63

382. If I pay a broker $\frac{1}{8}\%$ commission to buy 9 shares of L. and N. R.R. stock worth on the market $103\frac{1}{2}$, what will be the total cost?

$\$100 =$ par value of 1 share.
$\frac{1}{8}\%$ of $\$100 = \$.125 =$ commission on 1 share.
$\$.125 + \$103\frac{1}{2} = \$103.625 =$ cost of 1 share.
$\$103.625 \times 9 = \$932.625 =$ cost of 9 shares.

383. Find the annual income from 327 shares of stock which pays a semiannual dividend of $3\frac{1}{2}\%$?

$3\frac{1}{2}\%$ of $\$100 = \$3.50 =$ semiannual interest on 1 share.
$\$3.50 \times 2 = \$7.00 =$ annual interest on 1 share.
$327 \times \$7 = \$2289 =$ income on 327 shares.

384. What rate of interest on money invested shall I receive if I buy S.A.L. R.R. bonds at $53\frac{1}{2}$, which pay 4% interest, brokerage $\frac{1}{4}\%$?

4% of $\$100 = \$4 =$ income from 1 share.
$\frac{1}{4}\%$ of $\$100 = \$.25 =$ brokerage on 1 share.
$\$.25 + \$53\frac{1}{2} = \$53.75 =$ cost of 1 share.
$\$53.75$ invested brings $\$4$ in interest.
$\$53.75$ at $1\% = \$.5375$.
$\$4 \div .5375 = 7.5^{+} = 7\frac{1}{2}\% =$ rate of interest on money invested.

EXERCISE 231. — WRITTEN

1. Find the cost of 18 shares American Copper at $66\frac{3}{8}$, brokerage $\frac{1}{8}\%$.

2. Find the cost of 27 shares of stock (par value \$50) at $34\frac{5}{8}$, brokerage $\frac{1}{4}$%.

3. Find the amount realized from the sale of 32 shares of B. & O. R.R. stock at 86, brokerage $\frac{1}{8}$%.

4. Find the amount realized from the sale of 9 \$500 U. S. bonds, at $113\frac{1}{4}$, brokerage $\frac{1}{8}$%.

5. How many shares of stock having a par value of \$50 and a market value of \$67.50, can be bought for \$4869, brokerage $\frac{1}{4}$%?

6. How many U. S. \$100 bonds must I sell at $107\frac{3}{8}$ to raise sufficient money to pay a debt of \$3432.80, brokerage $\frac{1}{8}$%?

7. How much income will \$3600 Standard Oil stock, paying 36% dividend, yield?

8. What is the profit in buying 26 shares of Chicago and N. W. R.R. stock at 150 and selling for 159, brokerage on each transaction $\frac{1}{8}$%?

9. What is the gain in buying 37 shares of stock (par value \$50) at $49\frac{1}{2}$ and selling at $62\frac{1}{2}$, brokerage on each transaction $\frac{1}{4}$%?

10. What sum must be invested in U. S. 4's at $118\frac{1}{2}$, brokerage $\frac{1}{8}$%, to yield an income of \$160?

11. What sum must be invested in P. R.R. stock at $92\frac{1}{8}$ of par value, paying $3\frac{1}{2}$% half yearly, to give an income of \$630, brokerage $\frac{1}{4}$%?

12. What income will be obtained from the investment of \$5287.50 in stock at $105\frac{1}{2}$, paying 3% semiannually, brokerage $\frac{1}{4}$%?

13. A man bought Illinois Central R.R. stock at $137\frac{1}{8}$

and sold it for $142\frac{1}{2}$, making a profit of \$512.50. How many shares did he buy, brokerage $\frac{1}{8}$ % in each transaction?

14. A man buys 200 shares of Colorado Midland R.R. stock, paying 4 %, at 63 and holds it 2 years, receiving 2 dividends, and sells it at 78. Money being worth 6 % per annum and brokerage $\frac{1}{8}$ % on each transaction, how much did he gain?

15. Which is the best investment: 7 % stock at $127\frac{1}{2}$, 5 % bonds at $82\frac{1}{2}$, or money loaned at 6 %?

16. If a man buys U. S. 4 % bonds at $116\frac{3}{4}$, what per cent does he receive on his investment?

17. Which pays better, a 5 % stock at 90 or a 7 % bond at 130? How much better?

18. A man has \$3800 to invest. Which will yield the larger income, 5 % stock at 95, or $5\frac{1}{2}$ % bonds at par? How much larger?

NEGOTIABLE PAPERS

385. A written order to a bank to pay money, from one having money deposited in such bank, is called a **Check.**

No.--337-- *New York,*---Aug. 6,---*190* 8

THE CORN EXCHANGE BANK

FIFTH AVENUE BRANCH

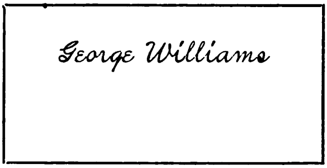
Pay to-------------J. C. Browne-------------*or order*

-----------------Twenty six-----------------*Dollars*

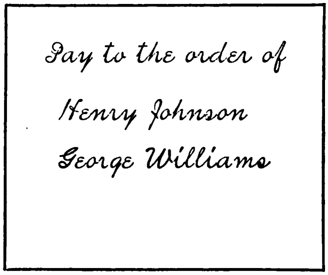
\$--26-- -----A. H. Hareus & Co.---

A BANK CHECK

386. A check may be made payable to Payee or to **Bearer**, in which case it may be collected by any one; or to Payee or **order.** If made payable to "order," it must be indorsed by the person to whose order it is made payable. A check may be "indorsed in blank," when the person to whose order it is made payable writes only his name across the back of the check as in A; or he may make a **special indorsement**, as in B.



A. Indorsed in Blank



B. Special Indorsement

387. A **Certified Check** is one upon which the cashier of a bank has written, in red ink, the word "Certified," with date, name of bank, and his name as cashier. This makes the bank responsible for its payment.

DRAFTS

388. A written order to one person to pay a specified sum of money to another person at a certain time is called a **Draft**, or **Bill of Exchange.**

389. The person who makes the order is called the **Drawer** of the draft; the person who is ordered to pay is the **Drawee**; and the person to whom the money is to be paid is the **Payee.**

390. A draft which is payable whenever presented to the drawee is called a **Sight Draft.**

391. A draft payable after date or at a certain time after sight is a **Time Draft.**

> *No.* 41 *Atlanta, Ga.,* Oct. 1, *190* 8
>
> *Pay to the order of*
>
> The Corn Exchange Bank of New York $ 250
>
> Two Hundred Fifty *Dollars.*
>
> *To T. T. Sands,*
> *New York.*
>
> R. T. Weldon & Co.

A DRAFT

392. A time draft must be presented to the drawee or person who is to pay, who must **accept** the draft by writing across its face the word "Accepted," together with the date and his signature.

393. A draft by one bank upon another in which it has a deposit is a **Bank Draft.**

PROMISSORY NOTES

394. A written promise to pay a certain sum of money at a specified time after date is called a **Promissory Note.**

395. The person who signs a note and thereby promises to pay is the **Maker** of the note. The **Payee** is the person to whom the promise to pay is made.

396. A note signed by one person only is called an **Individual Note.**

397. A note signed by two or more persons is a **Joint Note.**

398. A note is usually written so as to include the payment of interest at a specified rate for the time of the note.

$ 325	*New York, Oct. 1, 1908*

Three months after date I promise to pay to the order of Messrs. Stone and Herrick Three hundred and twenty-five dollars at the National City Bank of New York, with interest at six per cent.

Value received.

Thomas Chandler.

No. 47 Due Jan. 1, 1909

A PROMISSORY NOTE

399. When no rate is mentioned, a note bears interest at the legal rate of the state in which it is payable.

400. A note may be made payable to the payee or bearer, to the payee only, or to the order of the payee. Notes are indorsed in blank or to special persons, as with checks. The indorser of a note is responsible for its payment unless the words "Without Recourse" precede his signature.

401. The **Day of Maturity** of a note is the day on which it becomes due or the last day of the time for which it is drawn. In some states after the note becomes due, three days are allowed for its payment. These three days are known as **Days of Grace.**

BANK DISCOUNT

402. Bankers and others make a certain deduction from a note or draft for paying it before it is due. This deduction or charge is the simple interest on the face of the note or draft from the date on which it is paid to the date of maturity. This charge or deduction is known as **Bank Discount.**

403. The **Proceeds** of a note or draft is the amount of the note or draft less the discount and exchange.

404. The paying or transferring of money by means of checks, drafts, or money orders is called **Exchange.** The charge made by banks and other institutions for issuing or cashing these checks, drafts, or money orders is also called **Exchange.** The rate of exchange varies from $\frac{1}{8}$ to $\frac{1}{2}$ of 1%, or may be a certain fixed amount for different sums.

EXERCISE 232.—WRITTEN

1. A draft for $320 is sold by a bank in Raleigh, N.C., on a New York bank, rate $\frac{1}{4}$%. What is the exchange?

2. A draft for $125 is sold by a bank in New Orleans, La., on a bank in Chicago, Ill., rate $\frac{1}{5}$%. What is the exchange?

3. A United States postal money order for $76 costs

30 cts., and one for \$100 can be bought at the same price. What is the rate per cent on each?

4. Which is cheaper, a draft on a New York bank for \$40 at $\frac{1}{4}$%, or a U. S. money order for the same amount at a cost of 15 cts.?

5. If a bank in Chicago, Ill., charges 15 cts. for a draft for \$100 on a New York bank, what is the rate of exchange charged?

405. A note for \$100 at 6% interest drawn July 15, 1905, due 9 months after date, is presented to a bank Oct. 15, 1905, for discount. Find the discount and the proceeds.

The discount is the simple interest on \$100 at 6% from Oct. 15, the day it is discounted, to maturity. The note is drawn July 15, 1905, for 9 months, and is, therefore, due April 15, 1906. From Oct. 15, 1905, to April 15, 1906 = 6 months.

The interest on \$100 at 6% for 1 year = \$6.

The interest on \$100 at 6% for 6 months = $\frac{1}{2}$ of \$6 = \$3 = the discount.

\$100 − \$3 = \$97 = the proceeds.

EXERCISE 233. — WRITTEN

1. Find the discount on a note for \$480 dated Sept. 15, 1905, and payable in 90 days, if discounted Sept. 30, 1905, at 5%.

2. Find the proceeds of a note for \$375, dated May 5, 1907, payable Aug. 20, 1908, at 6% interest, if discounted by a bank July 15, 1907.

3. Find the discount on a note for \$2250, drawn Jan. 1, 1905, for 4 months at 8% interest, discounted Jan. 15, 1905.

Find the discount and the proceeds on the following:

4. $342.00. RALEIGH, N.C., Jan. 25, 1907.

Seven months after date I promise to pay to the order of Samuel Wolfe three hundred forty-two dollars, with interest at six per cent, for value received.

JAMES BAIRD.

Discounted Feb. 10, 1907.

5. $785.00. ATLANTA, GA., July 1, 1905.

Ninety days after date I promise to pay John Williams, or order, seven hundred eighty-five dollars, for value received.

WILLIAM JONES.

Discounted July 10, 1905, at 7%.

6. I wish to pay for a car-load of cattle which cost $860, but must give my note to the bank for 90 days to obtain the money. For how much must I draw the note to obtain this amount if it is discounted at 10 per cent?

7. I sell fifty acres of land for $62.50 an acre, on a cash basis, but the purchaser is not able to pay the money, and offers instead his note for 6 months at 8% interest. For how much must the note be drawn that I may receive the cash price after discounting the note at the bank?

8. I sell a car-load of cattle, taking in payment a promissory note for 60 days. After discounting the note at the bank at 5 per cent, I have $1487.50. For how much did I sell the cattle?

9. Write a promissory note for 90 days, with yourself as payee. Properly indorse it and find the bank discount and proceeds at the legal rate of interest in your state on the day it is drawn.

PARTIAL PAYMENTS

406. A payment made on a note which is not equal to the principal and the interest then due is known as a **Partial Payment.**

407. When such partial payments are made, the amount paid and the date, with the signature of the person receiving the payment, are indorsed on the back of the note.

Received on the within note:
\$320, March 1, 1904
John J. Jones
\$135, April 15, 1905
John J. Jones
\$85, June 20, 1906
John J. Jones

UNITED STATES RULE

408. The rule adopted by the United States Supreme Court for finding the amounts due on notes when partial payments have been made, has been adopted as the legal method by most states, and is as follows:

Find the amount of the principal to the time when the payment or the sum of the payments equals or exceeds the interest due; from this amount subtract the payment or the sum of the payments; treat the remainder as a new principal, and proceed as before.

409. A note for $935, drawn Jan. 1, 1903, due one year from date, at 6 per cent interest, has the following indorsements on it: March 1, 1904, $320; April 15, 1905, $35; June 20, 1906, $85.

What was the balance due Sept. 1, 1906?

SOLUTION BY UNITED STATES RULE

Principal Jan. 1, 1903	=	$935.00
Interest from Jan. 1, 1903, to March 1, 1904	=	65.45
Amount March 1, 1904	=	$1000.45
First payment March 1, 1904	=	320.00
New principal March 1, 1904	=	$680.45
Interest from March 1, 1904, to April 15, 1905	=	45.93
(Since the interest due April 15, 1905, is greater than the payment made, no new principal is calculated.)		
Interest from March 1, 1904, to June 20, 1906	=	94.13
Amount June 20, 1906	=	$774.58
Payments deducted June 20, 1906 ($35 + $85)	=	120.00
New principal June 20, 1906	=	$654.58
Interest from June 20, 1906, to Sept. 1, 1906	=	7.64
Amount due Sept. 1, 1906	=	$662.22

MERCHANTS' RULE

410. For calculating the amount due on accounts and notes bearing interest, on which partial payments have been made, merchants often use what is known as the **Merchants' Rule.** It is not as accurate as the United States method and is not legal, but for short periods, one year or less, it gives nearly the same results, and is easier. It is as follows: 1. Find the amount due on the original principal to the time final settlement is made. 2. Find the amount of each payment from the date it was made

to date of final settlement. 3. Subtract the sum of the amounts of the payments from the amount of the original principal at the time of final settlement.

If used for periods greater than one year, find the balance due at the end of each year by the rule above stated, and take this balance as a new principal.

411. Find the correct settlement on Feb. 15, 1908, on a note for \$100 dated March 1, 1907, at 6 % interest, with the following indorsements: May 1, 1907, \$20; July 15, 1907, \$50; Jan. 1, 1907, \$20.

Solution by the Merchants' Rule

Amount of principal for $11\frac{1}{2}$ mo.		= \$105.75
Amount of \$20 for $9\frac{1}{2}$ mos.	= \$20.95	
Amount of \$50 for 7 mos.	= \$51.75	
Amount of \$20 for $1\frac{1}{2}$ mos.	= \$20.15	
		= \$ 92.85
Correct settlement		= \$ 12.90

412. In a few states other rules are used. In such states the teacher should furnish the pupils with the special rule in use, and have the following problems solved by this special rule as well as by the rules indicated.

EXERCISE 234.—WRITTEN

Find the balance due on date of settlement by the United States Rule:

1. A note for \$300 at 6 % is dated March 1, 1905, and has the following indorsements: July 1, 1905, \$50; Sept. 1, 1905, \$30; Jan. 1, 1906, \$100. How much is due June 1, 1906?

2. A note for \$500 dated May 1, 1901, at 6% interest, has \$50 partial payments indorsed on it every 6 months from date to Nov. 1, 1905. What is the correct settlement Feb. 1, 1906?

3. A note is settled 4 years after date. Its face value is \$400, and it draws 8% interest. It has \$150 paid on it 1 year and 8 months before final settlement. How much is required to settle the note?

4. A note for \$800 dated April 10, 1901, has the following indorsements: June 20, 1901, \$30; July 10, 1901, \$50; Dec. 1, 1901, \$20; May 25, 1902, \$25; Sept. 10, 1902, \$100. How much was due Jan. 20, 1903, at 7% interest?

Find the amounts necessary to settle the following notes, by both the United States and the Merchants' Rules, and compare results:

5. A note for \$320 dated July 15, 1906, at 6% interest, is indorsed as follows: Sept. 25, 1906, \$80; Dec. 1, 1906, \$40; Jan. 1, 1907, \$50; June 1, 1907, \$10. How much was due July 1, 1908?

6. A note for \$150 dated May 10, 1906, for one year, at 6% interest, has indorsed on it payments of \$25 every three months. How much will be required to settle balance of note on the date it falls due?

7. An account amounting to \$375, due Jan. 1, 1904, is settled May 15, 1905. The following amounts had been paid on it: March 1, 1904, \$75; June 15, 1904, \$30; Sept. 10, 1904, \$80; Jan. 15, 1905, \$100. How much was required to pay the balance, with interest at 6%?

8. On Jan. 1, 1904, A owes B \$650, on which he agrees to pay 6 % interest and make a payment of \$75 every three months and the balance Jan. 1, 1905. When the balance is due, A is unable to pay it, and B charges him 8 % interest until paid. If A pays \$85 Feb. 1, 1905, and \$135 on July 10, 1905, how much money must he raise to pay the balance Sept. 20, 1905?

COMPOUND INTEREST

413. When the interest as it falls due is added to the principal, and the amount forms a new principal on which interest is paid, the owner receives **Compound Interest.**

414. Compound interest on notes is not now generally allowed by law, but savings-banks allow compound interest on balances remaining on deposit for a certain definite interest term. Interest may be compounded annually, semi-annually, or quarterly. Unless otherwise stated, it is usually compounded annually.

415. What is the compound interest on \$100 for 3 years at 6 %?

$\$100$ = first principal.
$\$100 \times .06 = \$6$ = first interest.
$\$100 + \$6 = \$106$ = second principal at end of 1 year.
$\$106 \times .06 = \$6.36$ = second interest.
$\$106 + \$6.36 = \$112.36$ = third principal at end of 2 years.
$\$112.36 \times .06 = \$6.7416$ = third interest.
$\$112.36 + \$6.7416 = \$119.10$ = amount at end of 3 years.

Therefore $\$119.10 - \$100 = \$19.10$ = compound interest on \$100 for 3 years at 6 %.

EXERCISE 235. — WRITTEN

Find the compound interest and compound amount on the following:

1. $375 for 4 yrs. at 4 %.
2. $125 for 3 yrs. 6 mos. at 5 %.
3. $650 for 5 yrs. at 6 %.
4. $2500 for 3 yrs. at 6 %.
5. $1875 for 4 yrs. at 8 %.
6. $3250 for 6 yrs. at 6 %.
7. $4325 for 3 yrs. at 5 %.
8. $7575 for 7 yrs. at 5 %.

Find the amount and interest compounded semi-annually on the following:

9. $500 for 2 yrs. 6 mos. at 6 %.
10. $250 for 2 yrs. 6 mos. at 7 %.
11. $1750 for 1 yr. 9 mos. at 8 %.
12. $2225 for 3 yrs. 6 mos. at 5 %.
13. $3575 for 3 yrs. 9 mos. at 6 %.
14. If a man deposits $2500 in a savings-bank, which pays 4 % semiannually, and leaves it for 2 yrs. 6 mos., will he have more or less money than if he had loaned it at simple interest for the same time at $4\frac{1}{2}$ %?
15. How much money did I have to my credit Jan. 1, 1908, if I made deposits as follows in a savings-bank, paying 4 % interest and compounding it Jan. 1 and July 1: July 1, 1906, $200; Aug. 1, 1906, $75; Dec. 1, 1906, $150; May 10, 1907, $100; and July 1, 1907, $135.

RATIO

416. How many weeks are there in one month? What part of one month is one week? What is the relation of one week to one month?

417. This relation is expressed in fractional form, $\frac{1}{4}$. It may also be expressed thus, 1 : 4, which is read 1 to 4.

The relation of two numbers of the same kind as expressed by division is called the **Ratio** of the first to the second.

418. The two numbers of a ratio are called its **Terms**.

EXERCISE 236.—ORAL

Express the following common fractions in the form of ratios:

1. $\frac{1}{4}$.	**4.** $\frac{4}{3}$.	**7.** $\frac{\frac{1}{2}}{\frac{2}{2}}$.
2. $\frac{4}{1}$.	**5.** $\frac{5}{6}$.	**8.** $\frac{\frac{3}{4}}{\frac{4}{4}}$.
3. $\frac{1}{8}$.	**6.** $\frac{6}{5}$.	**9.** $\frac{\frac{5}{6}}{1}$.

Express the following ratios as fractions:

10. 3 : 10.	**12.** 8 : 9.	**14.** 1 : 15.
11. 10 : 3.	**13.** 12 : 11.	**15.** 15 : 1.

419. The first term of the ratio is called the **Antecedent**. The second term is the **Consequent**.

420. Two quantities of different kinds cannot form the terms of a ratio. A ratio is always abstract, and the terms may be written as abstract numbers.

421. Multiply, also divide, both terms of the ratio 4 : 6 by 2.

Multiplying, we have 8 : 12; dividing, we have 2 : 3. If we express as a fraction the value of each ratio so obtained, we see that multiplying or dividing has not changed the value of the ratio.

Multiplying or dividing both terms of a ratio by the same number does not change its value.

422. In order to compare readily two or more ratios, it is convenient to reduce the ratios to such forms that the first terms of the ratios to be compared shall be the same, usually 1.

423. Reduce 7 : 28 to a ratio having 1 for its first term:

Dividing both terms by 7, we have 1 : 4. To obtain a ratio with one for its first term, divide the second term by the first term; take the quotient as the second term and 1 as the first term of this new ratio.

EXERCISE 237. — WRITTEN

Reduce each of the following to a ratio having 1 for its first term:

1. 12 : 24.
2. 3 : 9.
3. 6 : 60.
4. 7 : 21.
5. 9 : 81.
6. 16 : 39.
7. 19 : 72.
8. 11 : 23.
9. 24 : 98.
10. 96 : 700.
11. .1 : 3.
12. .9 : 6.
13. .784 : 9.
14. .62 : 11.
15. .7 : 6.
16. $\frac{1}{2} : 2$.
17. $\frac{1}{7} : 11$.
18. $\frac{6}{15} : 24$.
19. $\frac{9}{127} : 9642$.
20. $\frac{17}{129} : \frac{19}{127}$.

The following numbers express the density of population per square mile in various countries. Compare the population of the United States with that of other countries in the form of ratios, using the number representing the population of the United States as the first term in every case. Reduce all the ratios so that the first term shall be 1.

United States 25, Great Britain and Ireland 344, France 188, Germany 288, Italy 293, Belgium 609, Switzerland 208, Canada 1.

THE NUTRITIVE RATIO

424. What is the ratio of 2.5 lbs. to 16.25 lbs., with the first term reduced to 1?

What is the ratio between 1.5 lbs. protein and 10.5 lbs. carbohydrates and fats? Reduce to a ratio having 1 for its first term.

425. Find the nutritive ratio of the following standard ration for a dairy cow: 2.5 lbs. of digestible protein, 13 lbs. of digestible carbohydrates, and .5 lb. of digestible fats:

The fats in a ration are 2.4 times more valuable than the carbohydrates. To reduce the fats in this ration to the value of carbohydrates, the number expressing the amount of fats, .5, must be multiplied by 2.4. $.5 \times 2.4 = 1.2$. Adding this to the number expressing carbohydrates, we have $1.2 + 13 = 14.2$, the value of the carbohydrates and fats taken together. The nutritive ratio of this standard dairy ration is, therefore, as 2.5 is to 14.2, or, reducing the first term to 1, we have 1 : 5.68. The nutritive ratio is therefore 1 : 5.68.

426. The **Nutritive Ratio** of a ration is the ratio of the weight of the digestible protein to the sum of the

weights of the carbohydrates plus 2.4 times the sum of the weights of the fats.

Digestible protein : (2.4 × fats) + carbohydrates.

427. A **Balanced Ration** is one having the correct nutritive ratio for the particular animal and purposes for which it is being fed.

428. A **Narrow Ration** is one in which the proportion of protein to carbohydrates and fats is greater than the standard requirements.

429. A **Wide Ration** is one in which the proportion of protein to the carbohydrates and fats is less than the standard requirements.

EXERCISE 238. — WRITTEN

1. A ration consisting of 10 lbs. of corn and 20 lbs. of timothy hay contains 1.35 lbs. of digestible protein, 15.35 lbs. of carbohydrates, and .71 lb. of fats. What is the nutritive ratio?

2. A ration consisting of 10 lbs. of corn and 20 lbs. of alfalfa hay contains 2.99 lbs. of digestible protein, 14.57 lbs. of carbohydrates, and .67 lb. of fats. What is the nutritive ratio?

3. A ration consisting of 8 lbs. of corn, 1 lb. of cottonseed meal, 12 lbs. of alfalfa hay, and 20 lbs. of corn silage contains 2.50 lbs. of digestible protein, 12.52 lbs. of digestible carbohydrates, and .75 lb. of fats. What is the nutritive ratio? Compare these three rations with the feeding standard for a cow giving 22 lbs. of milk a day. (See page 250.) Which is too narrow? Which is too

wide? Which most nearly meets the requirements of the standard?

4. If a ration consisting of 10 lbs. of corn and 20 lbs. of red-clover hay contains 2.15 lbs. of digestible protein, 13.83 lbs. of digestible carbohydrates, and .77 lb. of digestible fats, what is the nutritive ratio?

5. If a ration for dairy cows, consisting of 7 lbs. of corn and cob meal, 1.5 lbs. of cotton-seed meal, 10 lbs. of clover hay, and 40 lbs. of corn silage contains 2.14 lbs. of protein, 13.02 lbs. of carbohydrates, and .93 lb. of fats, what is the nutritive ratio?

6. A ration consisting of 20 lbs. of corn, 5 lbs. of timothy hay, and 5 lbs. of corn stover contains 1.8 lbs. of protein, 17.13 lbs. of carbohydrates, and .96 lb. of fats. What is the nutritive ratio? Is this too wide or too narrow a ration for a fattening beef animal for the third period? (See page 250.)

7. Determine the nutritive ratio of the feeding standards in the table on page 250.

8–18. Find the nutritive ratio of rations Nos. 1 to 11, on pages 251 to 255.

Find the nutritive ratio of the following rations:

19. Red-clover hay, 12 lbs., corn stover, 15 lbs., corn, 12 lbs.

20. Corn silage, 40 lbs., red-clover hay, 5 lbs., corn stover, 5 lbs., corn, 6 lbs., cotton-seed meal, 3 lbs.

SPECIFIC GRAVITY

430. The **Specific Gravity** of a substance is the ratio of its weight to the weight of an equal volume of water.

431. To find the specific gravity of a substance, state the ratio of its weight to that of an equal volume of water, reducing this ratio so that the second term shall be 1.

EXERCISE 239 — WRITTEN

Find the specific gravity of each of these substances, the weight of which is given per cubic foot:

1.	Water,	62.42 lbs.	**6.**	Cork,	14.9808 lbs.
2.	Cast iron,	449.86 lbs.	**7.**	Maple wood,	46.815 lbs.
3.	Cast copper,	548.55 lbs.	**8.**	Ebony,	83.0186 lbs.
4.	Cast lead,	708.59 lbs.	**9.**	Butter,	58.6748 lbs.
5.	Ice,	58.04 lbs.	**10.**	Clay,	74.904 lbs.

Find the weight per cubic foot of the following substances, the specific gravities of which are given:

11.	Ash wood,	.84.	**24.**	Paraffin,	.874.
12.	Mercury,	13.598.	**25.**	Glycerine,	1.26.
13.	Glass,	2.89.	**26.**	Milk,	1.031.
14.	Cider,	1.02.	**27.**	Petroleum,	.836.
15.	Sea-water,	1.03.	**28.**	Olive oil,	.915.
16.	Silver,	10.47.	**29.**	Sulphur,	2.043.
17.	Gold,	19.26.	**30.**	Anthracite,	1.8.
18.	Steel,	7.816.	**31.**	Elm wood	.8.
19.	Tin,	7.291.	**32.**	Oak wood,	.845.
20.	Flint glass,	3.329.	**33.**	Yellow pine wood,	.657.
21.	Platinum,	22.069.	**34.**	Poplar wood,	.389.
22.	Copper,	8.878.	**35.**	Beech wood,	.852.
23.	Aluminum,	2.68.			

PROPORTION

432. When two ratios are equal, the four terms form a **Proportion**, *e.g.*, 2 : 4 :: 8 : 16 are in proportion, since $\frac{2}{4}$ equal $\frac{8}{16}$.

433. A proportion, therefore, is an expression of equality between two ratios and is written by placing the sign of equality or the double colon between the two ratios. The proportion 2 : 4 :: 8 : 16, or $2:4 = 8:16$, is read, 2 is to 4 as 8 is to 16.

434. The first and last terms of a proportion are called the **Extremes**, and the two middle terms are the **Means**.

435. When four numbers are in proportion, the product of the extremes equals the product of the means. This constitutes the test of the proportion.

EXERCISE 240. — ORAL

Complete the following statements of proportions:

1. 2 : 4 :: 3 : ?	5. 6 : ? :: 5 : 10.
2. ? : 4 :: 4 : 8.	6. 2.8 : 5.6 :: ? : 4.8.
3. 6 : 9 :: 12 : ?	7. 9 : 24 :: ? : 8.
4. 5 : 15 :: 6 : ?	8. 1.2 : ? :: 2 : 4.

436. Find the missing term in the following proportion:

? : 8.1 :: 1.25 : 5. The product of the extremes equalling the product of the means, $8.1 \times 1.25 = 5$

times the unknown number. The unknown number is therefore $\frac{8.1 \times 1.25}{5}$. Solving this example by cancellation, we have

$$\frac{8.1 \times \overset{.25}{\cancel{1.25}}}{\cancel{5}} = 2.05.$$

The completed proportion, therefore, is 2.05 : 8.1 : : 1.25 : 5.

EXERCISE 241. — WRITTEN

Find the missing terms in the following proportions:

1. ? : 136 : : 84 : 336.
2. 12 : 144 : : ? : 1728.
3. 15 : ? : : 6 : 32.
4. 22 : 5 : : 35 : ?
5. 17.4 : 191.1 : : 11.5 : ?
6. ? : 6.25 : : .75 : 8.36.
7. ? : 18 : : 45 : 32.
8. 18.2 : ? : : 7.3 : 9.1.

437. If 10 bus. of apples cost $7.50, what will 15 bus. of apples cost?

This problem may be stated and solved as a proportion since we have two ratios, one between the number of bushels of apples in the first instance and the number of bushels in the second instance, 10 : 15; the other between the amount paid in the first instance and the amount paid in the second instance $ 7.50 and $?. The price of apples remaining the same, these two ratios are equal. Therefore, we have

10 bus. : 15 bus. : : $ 7.50 : $?

Since unlike quantities cannot be multiplied, we may substitute abstract numbers instead of the first two terms, which will not affect the value of the ratio. We then have

10 : 15 : : $7.50 : $? Solving, we have $12.25, the cost of the 15 bus. of apples.

Arrange the three known quantities and the unknown

quantity of the problem in the form of two ratios which shall be equal. Solve as a proportion.

EXERCISE 242. — WRITTEN

1. If 25 lbs. of sugar cost \$1.50, what will 75 lbs. cost?

2. If 6 tons of hay cost \$72, what will 36 tons cost?

3. If a railroad ticket good for 80 miles costs \$1.80, what will a ticket good for 60 miles cost?

4. If a railroad ticket for 64 miles at $2\frac{3}{4}$ cts. a mile costs \$1.76, what will a ticket for 17 miles cost at the same rate?

5. If it costs 14.01 cts. to spray 3 acres 3 times, how much will it cost to spray 21 acres 3 times?

6. If the net profit from spraying 6 acres of potatoes is \$138, what is the profit from spraying 33 acres?

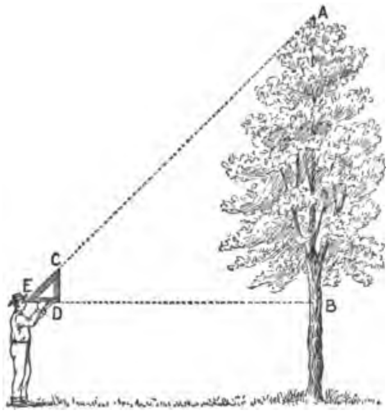
7. If at a certain moment a post 32 ft. high casts a shadow 48 ft. long, how long is the shadow of a tree which is 48 ft. high?

8. At the same moment how tall is a tree that casts a shadow 32 ft. long?

9. Measure the height of a post in your neighborhood and the length of its shadow; also, at the same time, measure the length of the shadow of any tall object, and by means of these measurements calculate the height of the tall object.

10. The height of a tall object is also often measured, as is shown in the accompanying figure, using a triangle of which $ED = DC$. The sides of the triangle are in the

proportion $AB : CD :: BE : DE$. Exclusive of the height of the triangle from the ground, what is the height of the tree, if the distance EB is 64 ft.?

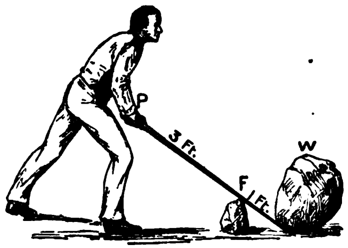


11. If in 15 lbs. of oats there are 13.35 lbs. of dry matter, 1.395 lbs. of protein, 7.125 lbs. of carbohydrates, and .54 lb. of fats, how many pounds of each of these are there in 2000 lbs. of oats?

12. If in 5 lbs. of cow-pea vine hay there are 4.4 lbs. of dry matter, .465 lb. of protein, 1.92 lbs. of carbohydrates, and .06 lb. of fats, how many pounds of each are there in 2000 lbs. of cow-pea vine hay?

13. If in alfalfa hay there is 10.6% of digestible protein, how much protein is there in 2500 lbs. of alfalfa hay?

LEVERS



438. In considering levers, three things must be recognized: (1) the **Power** applied to do the work or overcome the resistance; (2) the **Weight** or the resistance to be overcome; and (3) the immovable point on which the lever turns, called the **Fulcrum**.

In the figure on page 311 where is the weight? Where is the power? What is the fulcrum?

439. A lever can always be divided into two parts: (1) the distance from the weight to the fulcrum, called the **Weight Arm**; (2) the distance from the power to the fulcrum, called the **Power Arm.**

In the figure how long is the power arm? How long is the weight arm?

440. The factors of a lever are always in proportion, thus:

Power arm : Weight arm : : Weight : Power,

or, abbreviating,

$$Pa : Wa :: W : P$$

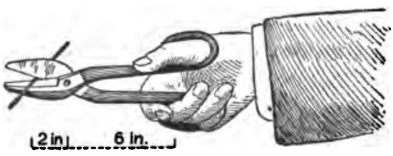
EXERCISE 243.—ORAL

1. In the figure on page 311 how many pounds must the man exert to lift the stone if it weighs 30 lbs.? 90 lbs.?

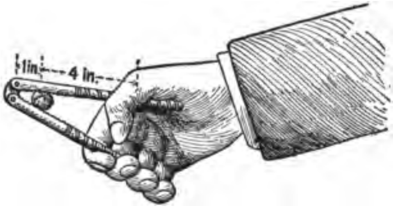
2. If the man exerts a power of 3 lbs., how heavy a stone can he lift? If he exerts 9 lbs.? 100 lbs.? $3\frac{1}{8}$ lbs.?

3. If the power arm is 9 ft. and the weight arm 1 ft., what will be the answers to No. 1? To No. 2?

4. In this figure where is the power? Where the fulcrum? Where the weight (resistance)? Will a wire be cut more easily near the tip of the shear blades, or near the base? Why? What is the power arm? The weight arm?



5. In this figure what is the length of power arm? Of weight arm?



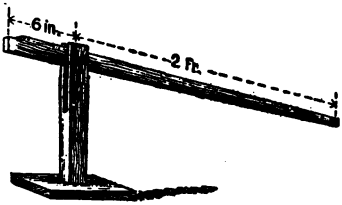
6. With a pressure of 80 lbs., how much resistance can be overcome?

EXERCISE 244.—WRITTEN

1. In raising a stone weighing 1400 lbs. with a weight arm 1 ft. long, how long must the power arm be to enable a man who can exert only 200 lbs. of power to do the work? If the weight arm is reduced to 9 ins., how long need the power arm be?

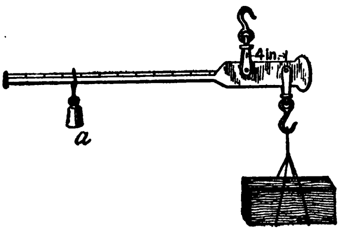
2. How much does the weight of a 156-lb. man, on the end of the power arm, fall short of raising a stone weighing 1200 lbs. with a lever having a power arm of 4 ft. and a weight arm of 1 ft.?

3. With a wagon-jack of the dimensions indicated, how much power is needed to lift the rear end of a loaded wagon, the rear end, loaded, weighing 1600 lbs.?



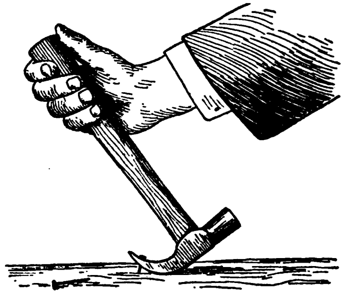
4. With steelyards as in the figure on page 314, with a weight (a) of 8 ozs., how far from the fulcrum must this weight be to balance 18 lbs.? 25 lbs.? 16 lbs.?

5. In fishing John held the large end of the pole stationary in the left hand. The right hand was 2 ft. 9 ins. farther up the pole, which was 12 ft. long. With his right hand it took a force of 8 ozs. to sustain the fish. What did it weigh?



Draw a diagram to aid in solving this problem.

6. In drawing a nail with a hammer the distance from the fulcrum to the nail is 2 ins., from fulcrum to hands is 11 ins. How much direct pull is exerted upon the nail if it requires 95 lbs. of pull upon the hammer handle to extract it?



7. A boy weighing 96 lbs. is swinging on a gate, having 2 hinges, 12 ft. from the hinges. It is 3 ft. 4 ins. from one hinge to the other. How much pull does the boy's weight exert upon the upper hinge? How much does it push upon the lower hinge? Draw a diagram before attempting to solve. Compare with the last problem.

8. Two men carry a weight of 195 lbs. suspended on a pole between them. If the weight is 6 ft. from one man and 9 ft. from the other, how many pounds does each carry? In order that one may carry $\frac{3}{4}$ of the weight where must the weight be hung?

COMPOUND PROPORTION

441. If 18 men working 6 hrs. per day can dig a canal 50 ft. long in 25 days, how many men working 10 hrs. per day can dig a canal 80 ft. long in 8 days?

This problem can be separated into simple proportions and solved as follows:

If 18 men can dig a canal in 25 days, how many men are required to dig the same canal in 8 days? This is expressed in proportion. (1) Solving, we get $\frac{225}{4}$ men. The canal is, however, 80 ft. long instead of 50 ft. long. If $\frac{225}{4}$ men can dig a canal 50 ft. long in 8 days, how many men are required to dig a canal 80 ft. long in 8 days? This is expressed in proportion. (2) Solving, we get 90 men. The previous statements have been made under the assumption that the men were to work 6 hrs. per day instead of 10 hrs. If 90 men can dig a canal 80 ft. long in 8 days, working 6 hrs. per day, how many men will be required to dig a canal 80 ft. long in 8 days, working 10 hrs. per day? This is stated in proportion. (3) Solving, we get 54 men, which is the final answer. This method of procedure may be shortened. Multiplying the completed proportions, 1, 2, and 3 together, term by term, we obtain a new proportion, which, expressed as a ratio, is shown in 4. We see that the answers obtained from the first two proportions cancel, leaving the second member a simple ratio. The ratio may now be expressed as a proportion, as is shown in 5, and solved, as follows:

(1) $8 : 25 :: 18 : ?$

(2) $50 : 80 :: \frac{225}{4} : ?$

(3) $10 : 6 :: 90 : ?$

(4) $\frac{8 \times 50 \times 10}{25 \times 80 \times 6} = \frac{18 \times \cancel{\frac{225}{4}} \times \cancel{90}}{\cancel{\frac{225}{4}} \times \cancel{90} \times 54}$

(5) $\left\{\begin{matrix} 8 : 25 \\ 50 : 80 \\ 10 : 6 \end{matrix}\right\} :: 18 : ?$ men.

$$\frac{\cancel{25} \times \overset{\cancel{10}}{\cancel{80}} \times \overset{3}{\cancel{6}} \times 18}{\cancel{8} \times \underset{2}{\cancel{50}} \times \cancel{10}} = 54 \text{ men.}$$

The fact that the first two answers cancel shows that it was unnecessary to obtain them to arrive at the final answer.

RULE 1. Place the unknown quantity as the fourth term of the proportion.

2. Place as the third term of the proportion the quantity given in the problem expressing the same kind of thing as the unknown quantity.

3. Take each of the other ratios separately, and arrange according to their relation to the ratio already stated.

4. The product of all the means divided by the product of all the extremes, except the unknown one, will give the answer.

442. The product of two or more simple ratios is a **Compound Ratio.**

443. A proportion in which either or both ratios are compound is a **Compound Proportion.**

EXERCISE 245.—WRITTEN

1. If 17 men working 7 hrs. a day can build a bridge in 22 days, how many men working 10 hrs. a day will it take to build the bridge in 4 days?

2. If 3 men can milk 35 cows in 1.5 hrs., how many men will it take to milk 65 cows in $\frac{1}{2}$ hr.?

3. If 3 teams working 5 hrs. a day can haul dirt as fast as 5 men can excavate it, how many teams working 7 hrs. a day are required to haul dirt as fast as 15 men can excavate it?

4. If 6 men can draw and house 32 tons of hay in 2 days, how many men are needed to draw and house 14 tons in 6 hrs.?

5. If 2 men cut 8 cords of wood in 4 days, how long will it take 12 men to cut 36 cords?

6. If 4 men with a one-horse plow break 28 acres in 7 days, how many days will it take 3 men with two-horse plows (a man with a two-horse plow doing twice as much work as a man with a one-horse plow) to break 42 acres?

7. If the eggs laid by 28 hens in 16 weeks are worth \$32.50, what will be the value of the eggs laid by 50 hens in 12 weeks?

8. If it requires 35 cows giving 77 qts. of milk each, per week, to supply 425 customers, how many cows giving 270 qts. per month will be required to supply 125 customers?

9. If 30 cows give 462 lbs. of milk in 21 days, how many cows are required to give 1200 lbs. in 7 days?

10. If 4320 lbs. of silage last 30 cows 48 days, how much silage is needed for 15 cows for 60 days?

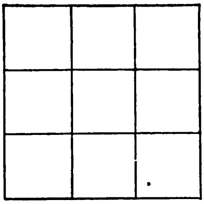
11. If the contents of a tank of water $2 \times 4 \times 10$ ft. weighs 4994 lbs., what will the contents of a tank $7 \times 12 \times 19$ ft. weigh?

12. If it takes 2 cu. yds. of concrete to make 40 posts $6'' \times 4\frac{1}{2}'' \times 7'$, how many yards will it take to make 678 posts $4'' \times 4'' \times 5'$?

13. If the weight of a volume of water $1 \times 1\frac{1}{3} \times 9$ ft. is —— (pupil fill blank), what is the weight of a piece of ebony $\frac{1}{2} \times \frac{1}{4} \times 3$ ft., ebony weighing 1.33 times as much as water of equal volume?

POWERS

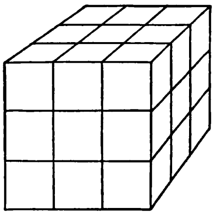
In the figure how many units are there on each side of



the square? How many in the whole square? There are 9 square units in a square of 3 units on a side, therefore, 9 is said to be the **Square** of 3. Similarly, a square with 4 units on each side has a total of 16 square units.

The **Square** of a number is the product of a number with itself.

444. In the figure how many units are there on each edge? How many cubic units in the cube? There being 27 cubic units in a cube with 3 units on an edge, 27 is said to be the **Cube** of 3.



The **Cube** of a number is the product of the number taken 3 times as a factor.

445. Squares and cubes are called **Powers** of a number. As the square and the cube are the second and third powers of numbers, so taking the number 4 times as a factor gives the fourth power, 5 times the fifth, etc.

446. The power of a number to be taken is indicated by a small figure written above and to the right of the

number, *e.g.*, 3^2 means the square of 3, 4^3 means the cube of 4, 6^9 means the ninth power of 6, etc.

447. The figure used to indicate the power taken is called the **Exponent.**

EXERCISE 246.—ORAL

Find the value of the following:

1. 6^2.	4. 1^3.	7. 1^9.	10. 12^2.
2. 9^2.	5. 8^2.	8. 10^2.	11. 25^2.
3. 20^2.	6. 11^2.	9. 3^4.	12. 30^3.

EXERCISE 247.—WRITTEN

Find the value of:

1. 84^3.	3. 1.25^3.	5. $(\frac{3}{4})^2$.	7. $(1\frac{1}{4})^3$.
2. 12^3.	4. $.75^2$.	6. $(\frac{7}{8})^3$.	8. 12.5^3.

448. We have seen that the square of a number is the number multiplied by itself, *e.g.*, the square of 24 is 24×24. We may write this multiplication thus:

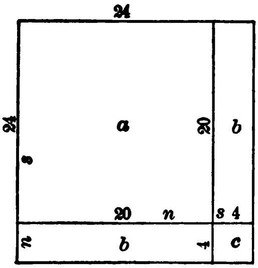
$$\begin{array}{lll} & 2 \text{ tens} + 4 \text{ units} & \\ & \underline{2 \text{ tens} + 4 \text{ units}} & \\ & 4 \text{ units} \times 2 \text{ tens} \quad 4 \text{ units}^2, & \text{result of multiplying by 4 units.} \\ 2 \text{ tens}^2 & 4 \text{ units} \times 2 \text{ tens}, & \text{result of multiplying by 2 tens.} \\ \hline \end{array}$$

$$2 \text{ tens}^2 + 2(4 \text{ units} \times 2 \text{ tens}) + 4 \text{ units}^2, \text{ sum of partial products.}$$

Since any number greater than 10 may be regarded as composed of the sum of two numbers, the square of the sum of any two numbers is equal to the square of the first number $+ 2 \times$ (the product of the first $\times$ the second) + the square of the last.

The same formula may be arrived at by considering the square of 24 as representing an area 24 units on each edge, as in the accompanying figure, and cutting the lines of the sides

into 20 units and 4 units to represent 2 tens and 4 units. It is then seen that the whole square of 24 consists of: the large square *a*, which is 20^2 and two times the rectangle *b*, which is $2 \times (20 \times 4)$, and the small square *c*, which is 4^2.



Represent the square of the same number, 24, in a diagram, similar to that just used, but cutting the lines into 18 and 6 units instead of into 20 and 4. Solve as above. Does this change affect the result?

We may represent the lines by letters *n* and *s*, as in the figure; then we have:

$$(n + s)^2 = n^2 + 2(n \times s) + s^2.$$

By this formula determine the square of 63:

$63 = 6$ tens and 3 units.
6 tens squared $= 60 \times 60 \quad = 3600$
$2 \times (6$ tens $\times 3$ units$) = 2 \times 60 \times 3 = 360$
3 units squared $= 3 \times 3 \quad = \underline{9}$
$\qquad 3969$

EXERCISE 248.—WRITTEN

Find by the last method given above, the squares of:

1. 62.	8. 67.	15. 199.	22. 672.
2. 79.	9. 93.	16. 86.	23. 999.
3. 24.	10. 99.	17. 205.	24. 897.
4. 81.	11. 107.	18. 640.	25. 862.
5. 63.	12. 129.	19. 783.	26. 978.
6. 72.	13. 15.	20. 297.	27. 209.
7. 84.	14. 22.	21. 248.	28. 679.

ROOTS

449. What number multiplied by itself will give 25? 16? 4? 100? What number used three times as a factor gives 8? 27? 125? 1000? What number squared equals 25? What number cubed equals 8? 27?

450. A number which when squared equals a certain number is said to be the **Square Root** of that number, *e.g.*, 5 is the square root of 25; 4 is the square root of 16.

451. A number which when cubed equals a certain number is said to be the **Cube Root** of that number, *e.g.*, 2 is the cube root of 8; 3 is the cube root of 27.

452. The root of a number is indicated by the sign, $\sqrt{}$, known as the **Radical Sign.** $\sqrt[3]{}$ indicates the cube root, $\sqrt[4]{}$, the fourth root, etc.

453. What is the square of 1? Of 10? Of 100? Of 1000? Of 10,000?

How many figures does it take to express the square root of a number of 1 or 2 figures? Of 3 or 4 figures? Of 5 or 6 figures? How many figures in the power equal 1 figure in the square root?

454. If a whole number be divided into groups of 2 figures each, beginning at units' place, the number of groups will equal the number of figures in the root.

455. Find the square root of 529:

Separating into periods, we see that since there are two periods, the root consists of two figures. The square of the tens of the root must be contained in the second period, 5. The greatest square in 5 is 4, the root of which is 2, which is therefore the tens' figure of the root desired.

```
    5'29)23
    400
43)129
    129
```

Subtracting the square of 2 tens or 400 from 529, we have 129. This remainder must contain, 2 × (tens × units) + units² (see paragraph 448). Two times the 2 tens = 4 tens. 4 is contained in 12, 3 times. We therefore take 3 as the next figure of the root. To find whether the remainder exactly contains 2 × (tens × units) + units², or what is equivalent (twice the tens + the units) × units, add the units to twice the tens and multiply by the units, thus: (3 + 40) × 3, securing 129. 23 is therefore the square root of 529.

To prove square root, multiply the square root by itself.

456. Find the square root of 15,713,296:

```
 )15,713,296)3964
   9
69)671
   621
786)5032
    4716
7924)31696
     31696
```

Proceed as in the preceding problem. In each step consider the part of the root already found as tens with relation to the next figure.

457. Find the square root of 94,864:

```
   94864)308
   9
608)4864
    4864
```

Since the divisor 6 is not contained in 4, 0 is placed in the root as well as in the divisor, and the next group is brought down.

458. Rule for the extraction of square root.

1. Separate the number into groups of two figures each, beginning at the decimal point.

2. Find the greatest square in the left period. Its root is the first figure of the required root.

3. Subtract the square of this root from the first period, and bring down the next period.

4. Divide the remainder by twice the part of the root, already found, considered as tens, as a trial divisor, securing the next figure of the root.

5. To the trial divisor add the new figure of the root, then multiply by the last figure found, and subtract the product from the last remainder.

6. Bring down the next period, and continue as above.

459. If the number is not a perfect square, add ciphers to the number and continue the division, expressing the result as a decimal.

460. What is the square of .25? Of .75? Of 1.25? How many more decimal places are there in the square of a decimal than in the decimal? How many decimal places are there in the square root of a decimal?

The square root of a decimal has half as many decimal places as the decimal itself.

Each group of the decimal must contain two figures. Annex a cipher, if need be.

461. What is the square of $\frac{1}{2}$? Of $\frac{3}{4}$? Of $\frac{2}{3}$?

What is the square root of $\frac{9}{16}$? Of $\frac{4}{9}$? Of $\frac{1}{4}$?

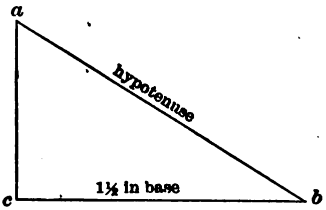
To obtain the root of a fraction, extract the root of both numerator and denominator separately.

EXERCISE 249. — WRITTEN

1. $\sqrt{7569}$.	9. $\sqrt{94\frac{3}{11}}$.	17. $\sqrt{8.7}$.
2. $\sqrt{743044}$.	10. $\sqrt{\frac{147}{432}}$.	18. $\sqrt{\frac{3}{11}}$.
3. $\sqrt{6889}$.	11. $\sqrt{6\frac{19}{25}}$.	19. $\sqrt{987.12}$.
4. $\sqrt{283024}$.	12. $\sqrt{3.33}$.	20. $\sqrt{\frac{1}{2}}$.
5. $\sqrt{7921}$.	13. $\sqrt{64289}$.	21. $\sqrt{\frac{3}{4}}$.
6. $\sqrt{235089}$.	14. $\sqrt{\frac{37}{43}}$.	22. $\sqrt{\frac{27}{19}}$.
7. $\sqrt{.9216}$.	15. $\sqrt{\frac{9}{10}}$.	23. $\sqrt{.0178}$.
8. $\sqrt{\frac{3025}{3248}}$.	16. $\sqrt{6\frac{1}{2}}$.	24. $\sqrt{69284.7632}$.

EXERCISE 250. — WRITTEN

In a right triangle the square of the hypotenuse, the side opposite the right angle, is equal to the sum of the squares of the other two sides.



1. Two sides of a right triangle are 76 and 84 ft. What is the length of the hypotenuse?

2. The hypotenuse of a triangle is 82 ft. One side is 79 ft. What is the length of the other side?

3. The base of a ladder is 12 ft. from the house. The top touches the eaves 39 ft. high. How long is the ladder?

4. A pasture shaped as a right triangle is 80 rds. 3 yds. 4 ft. on its long side, 12 rds. 2 ft. on its short side. How long is the other side?

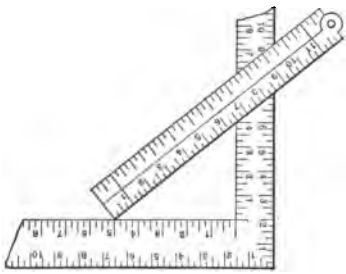
5. The area of a circle is 9678 sq. ft. What is its radius?

6. What is the diagonal of a rectangle 80×40 rds.?

7. The base of a 32 ft. ladder is 7 ft. from the house. How high on the wall can it touch?

8. In cutting across the diagonal of a lot twice daily for 5 days, how much walking is saved if the lot measures $203' \times 98'$?

In carpenter work and other building it is frequently necessary to know the hypotenuse of a right triangle. It may be found with sufficient accuracy for many such purposes by use of the square and rule.



9. What length of brace is needed from an upright post to a horizontal beam, the two ends of the brace to be 5 ft. and 4 ft. from the right angle? Place the rule on the square at 4 and 5 ins., as shown in the figure. Read the length of the hypotenuse in inches. Let each inch on the square and rule stand for a foot in the problem. Solve the same problem by square root, and compare answers.

CUBE ROOT

Since the extraction of the cube root may be much more easily understood after algebra has been studied, and since it is customary to defer its study until then, it will not be discussed here. The method of extracting the cube root is given in the Appendix for the benefit of any who may have occasion for its use.

EXERCISE 251

Miscellaneous Review Problems

1. What is the cost of spraying $6\frac{3}{4}$ A. of cucumbers 6 times with Bordeaux mixture, applying 100 gals. per acre each time, using 3 lbs. of bluestone at $7\frac{1}{2}$ cts. per pound, 6 lbs. of lime at 1 ct. per pound in each 50 gals. of mixture? Allow 33 cts. for labor of making each 100 gals.

2. Some tall structures are: the Eiffel Tower 984 ft., the Washington Monument 555 ft., the Cologne Cathedral 524 ft., Cheops Pyramid 486 ft., Strasburg Cathedral 474 ft., Bunker Hill Monument 221 ft. How much higher is the Eiffel Tower than each of the other structures named? How much higher is the Washington Monument than each of the others, except the Eiffel Tower?

3. Alcohol is .83 as heavy as water. Copper is 8.8 times as heavy. How much heavier is 1 cu. ft. of lead than 1 cu. ft. of alcohol, if 1 cu. ft. of water weighs 62.42 lbs.?

4. What is the cost of: 1 smoothing plane, \$2.40; 1 spoke shave, \$.90; 3 chisels at \$.42; 1 gauge, 52 cts.; 1 claw hatchet, \$.80; 1 ratchet brace, \$1.08; 5 bits, at \$.19, \$.28, \$33, \$.41, and \$.49; 1 screw-driver, \$.16; 1 level, \$2.00; 1 square, \$1.50; 1 rip saw, \$1.65; 1 hand saw, \$1.65?

5. From a roll of carpet $21\frac{1}{8}$ yds. long there are cut two pieces, one $1\frac{1}{8}$ yds., one $17\frac{3}{4}$ yds. How much remains?

6. Allowing $\frac{1}{8}$ in. per foot for shrinkage, how much

larger and wider than the desired article must be the pattern for a cast-iron support 9′ 11″ long × 2′ 1.3″ wide?

7. Allowing the same shrinkage for lead, how long must be the mould for a casting, to be, when finished, 2′ 4″ × 5″?

8. Allowing $\frac{3}{16}$″ per foot for shrinkage in brass castings, what would be the answer in the last two problems?

9. In an arithmetic class where term grade was valued at 75% and the examination at 25%, one student with a term grade of 84 made a final mark of 77. What was his mark on examination?

10. On an examination paper of 16 questions one question was three-fourths correct, three were one-half right, four were one-third correct, one was eight-ninths correct. What was the grade?

11. If the same errors had occurred on an examination paper of 12 questions, what would have been the grade? If on a paper of 10 questions? If on a paper of 9 questions?

12. If in feeding pigs, 1 bu. of corn produces 10.9 lbs. of gain, what price per bushel is obtained for corn when pigs sell for 5.75 cts. per pound?

13. If .92 A. of rape furnish feed for pigs equal to 1596 lbs. of corn and 796 lbs. of wheat middlings, what is the feeding value of an acre of rape, when corn is worth 45 cts. a bushel and wheat middlings $18 a ton?

14. Five pigs at 10 months of age average 243 lbs. in weight and sell for $5\frac{1}{2}$ cts. per pound. If they consumed 98 lbs. of wheat bran at $18 a ton, 1862 lbs. of corn at

50 cts. a bushel, and grazed .25 A. of clover, .25 A. of sorghum, and .60 A. of peanuts, what was the combined value per acre of these grazing crops for pig feeding?

15. If 1 A. of peanuts and 37.8 bus. of corn produce 1426 lbs. of gain in hogs and they sell for 5 cts. per pound, what is the value of an acre of peanuts if corn is worth 47 cts. per bushel?

16. The population of the United States in 1900 was 76,059,000. It is estimated that the number of births exceeds the number of deaths by 15.2 per 1000 of population every 10 yrs. Based on these estimates, what may the population of the United States be expected to be in 1910?

17. The increase in population of the United States through immigration in 1903 and 1904 was 800,000 annually. In 1905 and 1906 the increase was 1,000,000 annually. Taking the average of these four years as the probable increase through immigration for the next ten years, together with the results of the last problem, what is your estimate of the population of the United States in 1910?

18. Estimated in a similar way, basing each time upon the estimated population of the preceding decade, what will be the population in 1920? 1930? 1940? 1950?

---

19. Add each line without writing in columns:

a. 79, 46, 87, 93, 84, 72, 16.
b. 857, 965, 847, 964, 876.
c. 965, 864, 791, 862, 764, 968.
d. 6482, 9683, 7981, 8472, 6897, 9861.
e. 64,875, 89,672, 978,459, 679,821.

20. Estimate the average speed per mile of the trains as given in the time-table on page 145.

21. It requires $15\frac{1}{2}$ days for the eggs of the honey bee to develop into honey bees that are to become queens: $\frac{6}{31}$ of this period is required for the eggs to hatch; $\frac{25}{31}$ of this period is required to mature the larvæ and pupæ. How many days are spent in the egg state? How many in the larval and pupal states?

22. It requires $\frac{11}{31}$ more days for the eggs to develop to become worker bees than to become queen bees: $\frac{1}{7}$ of this period is required for the eggs to hatch; $\frac{6}{7}$ to mature the larvæ and pupæ. How many days are spent in the egg state? How many in the larval and pupal states?

23. The plant louse often produces in 12 generations in one season, 10,000,000,000,000,000,000,000 offspring. These are each about $\frac{1}{10}$ of an inch long. If all should live, how many miles long would such a procession be, arranged single file? How many times would this procession reach around the earth, considering the circumference of the earth as 25,000 miles?

24. If on an average 1 cattle tick produces 1000 young and there are four generations in one year, how many ticks may be produced in the fourth generation? If one-half these ticks are females, $\frac{1}{2}$ inch in length, and one-half males, $\frac{1}{8}$ of an inch long, arranged single file, how many times would this procession encircle the earth?

A family of two persons has an income of $520. Their expenses are as follows:

Rent	$120	Clothing	$60
Food	210	Fuel	30

Light	$ 7	Charity	$10
Insurance	24	Church	10
Replenishing	10	Recreation	10
Car fare	5	Incidentals	10
Literature	5	Emergencies	14

25. What per cent of the income is spent for rent?

26. What per cent is spent for food?

27. What is the ratio of money spent for rent to that spent for food?

A family of three persons—man, wife, and one child 6 years old—has an income of $780. The itemized expenses are as follows:

Rent	$ 120	Car fares	$ 10
Food	320	Literature	10
Clothing	120	Church	15
Fuel	40	Recreation	20
Light	10	Charity	10
Insurance	40	Incidentals	20
Replenishing	20	Emergencies	25

28. If the food of the child is regarded as $\frac{1}{2}$ of that of the man, and the food of the wife $\frac{7}{10}$ that of the man, what is the cost of food for each?

29. What per cent of the money expended for food by the first family is expended for food by the second family?

30. What is the ratio of the sum of the last six items of the first family to the same items of the second family?

31. The five states of greatest population in 1900 were: New York 5,997,853, Pennsylvania 5,258,014, Illinois 3,826,351, Ohio 3,672,316, Missouri 2,679,184. How

much does the population of the two latter together exceed that of New York?

32. Five sugar-producing districts are: Cuba 1,664,-862,000 lbs., Louisiana 695,101,878 lbs., Hawaiian Islands 520,138,232 lbs., Philippine Islands 435,000,000 lbs., Porto Rico 122,000,000 lbs. How much does the produce of the other four together exceed that of Cuba?

33. The five leading states in wheat production are: Minnesota \$42,345,672, Kansas \$32,469,706, North Dakota \$28,383,767, Ohio \$27,788,094, Indiana \$24,208,-398. What per cent of the wheat produced by these five states is grown in each state?

34. The iron manufactured in five states was: Pennsylvania \$264,571,624, Ohio \$65,206,828, Illinois \$39,011,-051, New York \$15,849,531, New Jersey \$11,018,575. Find the total amount. The production of each state is what per cent of the total?

35. The textile manufactures of five leading states were: Massachusetts \$184,938,074, Pennsylvania \$132,-367,499, New York \$86,171,293, Rhode Island \$67,005,-615, New Jersey \$52,831,023. The production of each state is what per cent of the total of the five states?

36. The number of miles of railroad for every 100 sq. mis. of area in five groups of states was: Middle Atlantic States 15.8, New England 11.72, Central 10.63, Southern 5.31, Western 2.09. What was the average mileage per 100 sq. mis.? The mileage per 100 sq. mis. for each section is what per cent of the total?

The following table shows the value of raw cotton and

its manufactured product for 6 years, with the number of wage-earners engaged:

MATERIALS	VALUE OF PRODUCT	WAGE-EARNERS	YEAR
$447,546,540	$759,262,283	517,237	1890
303,709,894	532,673,488	384,251	1880
353,249,102	520,386,764	274,943	1870
112,842,111	214,740,614	194,083	1860
76,715,959	128,769,971	146,877	1850
11,540,347	15,454,430		1840

37. What was the per cent of increase in value of the annual product each decade based upon the preceding decade?

38. What was the per cent of increase in value of manufactured cotton over the crude cotton each decade?

39. What was the per cent of increase in number of wage-earners in each decade since 1850?

40. At 12 cts. per pound, for how much will a 500-lb. bale of cotton sell?

41. A bale of cotton weighs 500 lbs. and sells for $60. The bagging and ties (strap iron) used to wrap it weigh 24 lbs., and are included in the total weight of the bale. What is the actual cost of the cotton per pound?

42. In making a 450-lb. bale of cotton into thread for cotton cloth with a loss of 17% due to particles of leaf, sand and other impurities, how much cotton is actually used?

43. The warp threads in a sheet weigh $10\frac{1}{2}$ ozs., the filling threads weigh $8\frac{3}{4}$ ozs., 20,160 yds. of warp threads

weigh 1 lb., and 22,260 yds. of filling weigh 1 lb. Find the number of yards of warp and filling used in the sheet.

44. A stripe gingham cloth is made 28'' wide, 56 ends per inch. The colors arranged in the following order form a pattern: 28 ends white, 16 ends blue, 8 ends black, 4 ends red. How many times is the pattern repeated in the cloth, and how many ends of each color are there?

45. A loom weaves 50 yds. of calico cloth in $10\frac{1}{2}$ hrs. How many yards will be woven in 60 hrs.?

46. If 1 lb. of cotton-seed meal is equal to 1.75 lbs. of corn for cattle feeding, what is the value of a ton of cotton-seed meal for cattle feeding when corn is worth 50 cts. a bushel? 1 bu. = 56 lbs.

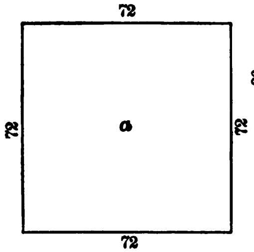
47. If for cattle feeding 3 lbs. of cotton-seed are equal to 3.48 lbs. of corn, what is the value of cotton-seed per ton for cattle feeding when corn is worth 45 cts. a bushel?

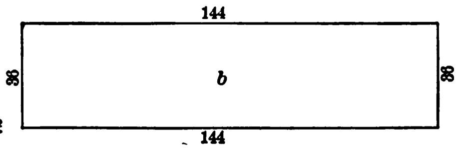
48. Ten pigs weighing 56 lbs. each bought for $50, after feeding for 120 days weigh 224 lbs. each. They then sell for $5.625 a hundred. What was the net profit if it cost 4.25 cts. in feed to produce a pound of gain?

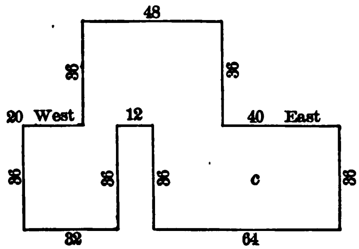
49. If it costs 4.07 cts. to produce a pound of gain with hogs fed corn and wheat middlings, and 3.25 cts. to produce a pound of gain with hogs fed corn and green clover, how much less will it cost to grow 12 hogs from 50 lbs. up to a weight of 243 lbs. each on corn and clover than on corn and wheat middlings, if no charge be made for the clover pasture?

50. A beef animal weighing 986 lbs. is bought for 3.875 cts. a pound and is fed 30 lbs. of silage worth $3 a ton, 10 lbs. of clover hay worth $8 a ton, 8 lbs. of corn worth 41 cts. a bushel, and 3 lbs. of cotton-seed meal worth $32 a ton, per day for 180 days. What is the profit on the feeding if the animal gains 1.95 lbs. a day and sells for $5.37½ per hundredweight? If the animal gains 2.1 lbs. a day and sells for $5.42 per hundredweight?

51. How much will it cost to fence each of the lots of equal area, *a*, *b*, *c*, as chicken lots, if the figures showing







dimensions in the diagrams be taken to indicate feet: posts 8 ft. apart; cost of posts 19 cts. each; cost of digging post-holes and setting posts 6 cts. each; cost of wire netting 5 ft. high, 7 cts. a linear yard; estimate exclusive of cost of other labor?

52. If the figures indicating dimensions in these diagrams be taken to mean yards, what will be the cost of fencing each lot with boards: placing posts 8 ft. apart; the posts costing 17 cts. each; cost of digging post-holes

and setting posts 6 cts. each; fence to be 5 boards high at 11.2 cts. for each board 16 ft. in length. Estimate exclusive of cost of nails and labor of construction.

53. If the figures indicate rods, what will be the cost of fencing each with barbed wire: posts 16 ft. apart; cost of posts 14 cts. each; cost of setting posts $1\frac{1}{2}$ cts. each; fence 4 wires high costing $2.75 per hundred pounds of 1480 ft. Estimate exclusive of cost of staples and labor of construction.

54. Procure at home the prices of the materials used in the last three problems and the cost of construction in your community, and using such facts solve each of these problems.

55. In plowing, a furrow one foot wide is turned. How many times must the field *a* be crossed to plow all of it? How many turns must be made? (Figures indicate rods.)

56. If each turn consumes 30 secs., what time is lost in turning in field *a*? In field *b*, plowing lengthwise? In field *c*, plowing from east to west? (Figures indicate rods.)

57. What is the value of the time lost in turning in plowing each field at $3.50 per day of 10 hrs.? (Figures indicate rods.)

58. In raking the same fields with an eight-foot rake, how many turns are made? How much time is lost in each field? (Figures indicate rods.)

59. With a twelve-foot rake, what will be the number of turns and the time lost in each field? (Figures indicate rods.)

60. Two wagon tires, one 22 ft. the other 17 ft. in circumference, lie upon a floor in contact at one point. How far apart are their centres?

61. A window of the third story of a house is 32 ft. from the ground. How long must a ladder be to reach it, with the foot of the ladder 10 ft. from the building?

62. At $18 a thousand feet, what will be the value of a piece of timber 18 ft. long, 10 ins. wide, and 8 ins. thick?

63. How many tons of silage are there in a silo 16 ft. in diameter, if the silage is 24 ft. deep in the silo and 1 cu. ft. weighs $33\frac{1}{3}$ lbs.?

64. How many barrels of water will a tank 8 ft. in diameter and 8 ft. high hold?

65. How many tons of silage will a silo 10 ft. in diameter and 20 ft. high hold, filled within 5 ft. of the top, if a cubic foot of silage from such a silo weighs 30 lbs.?

66. To insure the silage keeping well, a silo should not be less than 30 ft. deep. What must be its diameter to hold enough silage to feed 25 cows 40 lbs. each a day for 185 days, if a cubic foot of silage weighs 37 lbs.?

67. When the temperature is 37.5° Centigrade, what will a Fahrenheit thermometer indicate?

68. If I pay $3.50 a cord for wood and $.95 a cord for sawing, how much will a pile of wood 29 ft. long, 8 ft. wide, and $3\frac{1}{2}$ ft. high cost me?

69. If a ring is 18 karats fine, what per cent of it is gold? (1 karat $= \frac{1}{24}$.) If it is 14 karats fine, what per cent of it is gold?

70. A haberdasher buys hats at $18 a dozen and sells

them at a profit of $33\frac{1}{3}$ %. What is the gain? What is the selling price?

71. A man invests $1250 so as to gain $12\frac{1}{2}$ %. What is his income from his investment?

72. If flour costs $ 6 a barrel, at what must it be sold to gain $8\frac{1}{3}$ %? To gain $16\frac{2}{3}$ %?

73. A man purchases a hogshead of 12 gross of glass articles for $45; 5 % was broken in shipping. At what price per dozen must the remainder be sold to gain 20 % on the whole?

74. I buy a 30-gal. barrel of vinegar at 25 cts. a gallon. Upon examination it is found that 4 gals. 2 qts. have leaked out. How must the remainder be sold to gain 36 % on the whole?

75. A and B are engaged in different lines of business with a capital of $4000 each. The first year A gains and B loses 20 % of the investment. The second year A loses and B gains 20 % on the capital each has then. Which is now the better off?

76. A farmer losing 20 % of his tobacco crop by hail received from the insurance company in which the crop was insured for 75 % of its value, the sum of $450, covering the loss. For what amount was the entire crop insured?

77. 10 % of 5 % of a number is $2.88. What is the number?

CROP ROTATION

Systems of crop rotation prove to be more profitable under most conditions than the continuous growing of

one crop. The conditions in one section of the South are illustrated on the opposite page by the record of a 90-acre farm continuously cropped and that of a similar farm divided into three 30-acre fields and the crops rotated.

The cost and produce per acre for each field for a series of years are given.

78. Find the profit on each 30-acre field for each year and the profit each year on the whole farm under rotation.

79. Find the profit of the whole farm each year under continuous cropping.

80. Which is the more profitable for the first year? How much more profitable than the other method?

81. Which is the more profitable for the last year? How much more profitable than the other method?

82. How much does the profit of the last 3 years under rotation exceed the profit of the last 3 years under continuous cropping?

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83. A farmer has land that, with \$1.86 worth of fertilizer per acre and \$6.85 per acre for labor and other expenses, including taxes, will produce 56 bus. of corn per acre. With corn at 50 cts. a bushel the land is drawing 5% on what capital?

84. Land that, with \$1.46 worth of fertilizer and \$12.50 for other expenses, will produce $\frac{2}{3}$ of a bale of cotton, worth for the seed \$5, for the lint 333 lbs. at 11 cts. per pound, is drawing 4% on what capital?

85. Land that will produce 260 bus. of potatoes, worth 50 cts. a bushel, with an outlay of \$96 for all expenses, is paying interest at 4% on what amount?

	1st Year	2d Year	3d Year	4th Year	5th Year	6th Year
Crops Rotated Fields 30 A. Each	Small Grain followed by Cow-peas	Cotton followed by Crimson Clover	Corn followed by Cow-peas	Small Grain followed by Cow-peas	Cotton followed by Crimson Clover	Corn followed by Cow-peas
	Oats 25 bus. per A. at 40¢ . Cost $8 per A. Profit . . .	Cotton 335 lbs. per A. at 10¢ Cost $20 per A. Profit . . .	Corn 27 bus. per A. at 50¢ Cost $9 per A. Profit . . .	Oats 35 bus. per at A. 40¢ . Cost $8.75 per A. Profit . . .	Cotton 500 lbs. per A. at 10¢ Cost $22 per A. Profit . . .	Corn 37 bus. per A. at 50¢ Cost $11 per A. Profit . . .
	Cotton followed by Crimson Clover	Corn followed by Cow-peas	Small Grain followed by Cow-peas	Cotton followed by Crimson Clover	Corn followed by Cow-peas	Small Grain followed by Cow-peas
	Cotton 250 lbs. per A. at 10¢ Cost $20 per A. Profit . . .	Corn 25 bus. per A. at 50¢ Cost $9 per A. Profit . . .	Oats 30 bus. per A. at 40¢ . Cost $8.50 per A. . . . . . Profit . . .	Cotton 450 lbs. per A. at 10¢ Cost $21 per A. Profit . . .	Corn 35 bus. per A. at 50¢ Cost $11 per A. Profit . . .	Oats 40 bus. per A. at 40¢ . Cost $9 per A. Profit . . .
	Corn followed by Cow-peas	Small Grain followed by Cow-peas	Cotton followed by Crimson Clover	Corn followed by Cow-peas	Small Grain followed by Cow-peas	Cotton followed by Crimson Clover
	Corn 20 bus. per A. at 50¢ Cost $9 per A. Profit . . .	Oats 30 bus. per A. at 40¢ . Cost $8 per A. Profit . . .	Cotton 400 lbs. per A. at 10¢ Cost $20.50 per A. . . . . . Profit . . .	Corn 30 bus. per A. at 50¢ Cost $10 per A. Profit . . .	Oats 38 bus. per A. at 40¢ . Cost $9 per A. Profit . . .	Cotton 550 lbs. per A. at 10¢ Cost $22.50 per A. . . . . . Profit . . .
Total when Rotated	Profit . . .	Profit . . .	Profit . . .	Profit . . .	Profit . . .	Profit . . .
Continuous Cropping 90 A.	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
	250 lbs. per A. at 10¢ . . Cost $20 per A. Profit . . .	250 lbs. per A. at 10¢ . . Cost $20 per A. Profit . . .	250 lbs. per A. at 10¢ . . Cost $20 per A. Profit . . .	250 lbs. per A. at 10¢ . . Cost $20 per A. Profit . . .	250 lbs. per A. at 10¢ . . Cost $20 per A. Profit . . .	250 lbs. per A. at 10¢ . . Cost $20 per A. Profit . . .

86. Land near a certain city produces \$300 worth of garden truck per acre at a total expense of \$120 per acre. Land of similar quality, but so located as to have no market for truck, can raise of its most profitable crop, corn, 60 bus. per acre at 50 cts. per bu. at a cost of \$8.50. Disregarding taxes, estimate the capital or value of each farm at 4% interest.

87. What is the increased value of the first farm, due to its location?

88. A field produces 816 lbs. of tobacco averaging 8 cts. per pound at a total cost of \$47 per acre. The land is drawing interest on what capital at 4%? Suppose the tobacco wilt to take possession of the field and render tobacco raising impossible and that the next most valuable crop is corn, 23 bus. per acre, valued at 65 cts. per bushel, costing to raise \$9.20 an acre. What capital at the same rate will the land then represent?

89. If the yellow yam sweet potato contains 16.64% of starch, how many pounds are required to contain 2 tons of starch?

90. The Red Bermuda contains 2.59% of sugar, how much sugar is there in 3 cwts.? How many tons are required to contain 2.9 T. of sugar?

91. The average starch content of corn is 65%, wheat 58%, rice 75%, Irish potatoes 18%, sweet potatoes about 21%. What is the value of the starch in a ton of each of these crops at the following prices: corn starch 1.93 cts., potato starch 3.57 cts., rice starch 6.53 cts., wheat starch 4.78 cts. per pound?

92. If there is 28% of starch in the Red Bermuda sweet potato and 9.79% in the Early Nansmond, how

much more starch is there in 2 T. 3 cwts. of the first variety than in 3 T. 7 cwts. of the second? If 58 % of the starch present can be separated, how much can be had in each case?

93. At \$3.50 a day for a man and team, what is due for 3 wks. 4 days 3 hrs. work?

94. At \$9.00 a day for a man, team, and harvester, what is due for 3 days 7 hrs. work?

95. Ascertain the local price of such labor in your community, and solve the last two problems, using these prices.

96. Drawing produce on a good road a farmer can haul four loads daily, on a poor road only two loads daily. How many loads less are hauled in a week because of poor roads? In 6 weeks? Counting 4 loads to the day, what is the loss in this time to one man with team?

97. On poor roads a teamster can draw $\frac{5}{6}$ of a ton at each load, on a good road $1\frac{1}{2}$ T. Allowing four loads to each day on a good road and two loads a day on a poor road, how much lost time is occasioned by the poor road in drawing 1600 bus. of potatoes to market (1 bu. = 60 lbs.)? How much is the loss at \$3.50 a day?

98. If 3 forty-quart cans of milk containing 3 % of butter fat bring $6\frac{1}{2}$ cts. a quart, for what should 6 sixty-five-quart cans of 4 % milk sell?

99. Grafting wax is made of: resin 5 ozs., beeswax 5 ozs., tallow 3 ozs. State the composition in per cents.

100. If 12 % of the stalks of a corn-field producing 63 bus. per acre are barren, how many bushels are lost through barren stalks?

101. What is the weight of a 40 bu. wheat crop on an acre if the grain weighs 2400 lbs. and the straw weighs 3600 lbs.? What per cent of the total crop is grain?

102. The following amounts of water expressed as inches in depth are required to mature wheat crops of the following yields: 15 bus. to the acre require 4.498 ins.; 20 bus. require 5.998 ins.; 25 bus., 7.497 ins.; 30 bus., 8.997 ins.; 35 bus., 10.495 ins.; 40 bus., 12 ins. An acre of water 1 in. deep weighs 226,584 lbs. How many more pounds are required to raise a 35-bu. crop than a 15-bu. crop? A 20-bu. crop than a 15-bu. crop? A 40-bu. crop than a 15-bu. crop? Make other similar problems from the data given.

A Week's Food for Two Persons

Meats	*Cost*	*Groceries and Milk*	*Cost*
2 lbs. flank of beef . .	20¢	2 lbs. sugar	16¢
1 lb. pickled tongue . .	15¢	baking powder	05¢
½ lb. salt pork . . .	06¢	seasoning	10¢
½ lb. bacon	08¢	3 lbs. bananas	15¢
3 lbs. veal cutlet . . .	24¢	5 lbs. apples	10¢
1 lb. fresh fish	18¢		
		Vegetables	
Groceries and Milk		potatoes 1 pk. (15 lbs.) .	15¢
7 qts. milk	35¢	cabbage 2 lbs.	08¢
2 lbs. butter	40¢	lettuce ¼ lb.	05¢
1 doz. eggs	20¢	peas 1 lb.	15¢
½ lb. of coffee	08¢	string beans 1 lb. . . .	05¢
⅛ lb. tea	08¢	turnips 5 lbs.	05¢
6 lbs. flour	23¢	squash 5 lbs.	08¢
5 lbs. corn meal and 2 .		2 lbs. dried beans . . .	10¢
lbs. oatmeal . . .	20¢	2 lbs. canned tomatoes .	12¢

103. Find the total cost of supplies for a week.

104. At the same rate what will the food cost for the year?

105. If the food costs $\frac{1}{3}$ of the income, what is the income?

106. Find the amount of digestible protein in the meat and fish consumed. (For data consult tables on pages 272 and 273.)

107. Find the amount of digestible protein in the vegetables. Find the amount of digestible protein in the groceries and milk.

108. Digestible fats in meat and fish.

109. Digestible carbohydrates and fats in groceries.

110. Digestible carbohydrates and fats in vegetables.

111. If in one day a man requires 100 grams of protein, 60 grams of fats, and 400 grams of carbohydrates, and a woman requires 90 grams of protein, 40 grams of fats, and 350 grams of carbohydrates, how much does the diet for a week exceed or fall short of this standard? (See preceding page.)

112. The cost of spraying cantaloupes being $4.47 an acre per season, what is the cost for 12 A.?

113. The net profit from spraying one acre of cucumbers on Long Island being $163.50, what would be the profit at the same rate from spraying 14 acres?

114. The net profit from spraying an average-sized tree from 12 to 20 years old throughout one season at a total cost of 50 cts. is from $3 to $7. When apples are worth $1 per bushel, what are the highest and the lowest per cents realized upon the investment?

115. Sprayed and unsprayed apple trees yielding as is shown in the table below, what is the total yield of the 6 sprayed and the 3 unsprayed trees, in bushels, in sound apples and in diseased apples?

Date of Spraying and Tree Number	Yield	Sound Apples	Diseased Apples
Trees sprayed July 10 and 26 and Aug. 9:	*Bushels*	*Number*	*Number*
No. 1	15.76	1278	144
No. 2	18.26	1563	253
No. 3	18.76	1526	163
No. 4	10.26	749	103
No. 5	13.76	1394	17
No. 6	24.50	2164	309
Trees not sprayed:			
A	5.875	3	1276
B	9.35	135	1670
C	5.875	50	1298

116. The population of several American and foreign cities for two decades is shown in the following table. What was the per cent of increase in each city? Was the average increase greater abroad or in the United States?

	1870	1890
New York	950,000	1,515,301
Berlin	800,000	1,576,794
Hamburg	348,000	562,260
Boston	342,000	448,000
Cologne	144,800	287,800
Buffalo	155,000	255,600
Magdeburg	97,500	202,000
Milwaukee	116,000	205,000

117. The population of the United States in 1790 was 3,928,037; in 1800, 5,308,937; in 1810, 7,239,814; in 1820, 9,638,191; in 1830, 12,860,702; in 1840, 17,017,738; in 1850, 23,151,876; in 1860, 31,335,120; in 1870, 38,784,597; in 1880, 50,152,866; in 1890, 62,622,260; in 1900, 76,059,-000. What was the increase in population the first decade given? The second? The third? For each succeeding decade?

118. What was the increase from 1800 to 1900? How much greater was the increase during the last decade than was the total population of 1790? Than of 1820?

119. According to the twelfth census the working population of the United States was engaged as follows:

Pursuit	Number	Per Cent of Total Population
Agricultural pursuits	10,438,219	———
Professional service	1,264,735	———
Domestic service	5,691,746	———
Trade and transportation	4,778,233	———
Manufacturing and mechanics	7,112,987	———
Total	———	———

What per cent of the total working population was engaged in each pursuit?

120. The number of agricultural college students in the same year was 5035. What per cent was this of the number engaged in agricultural pursuits?

121. According to the census of 1899, 93 % of the people of the United States lived on annual incomes of $400 for three persons in a family. According to statistics each

member of the average Pennsylvania farmer's family receives $198.26 yearly. What per cent above the average income do these farmers receive?

122. In 1820, of the people engaged in commerce, manufacturing, and agriculture, $\frac{5}{6}$ were engaged in agriculture. In 1900, $\frac{1}{2}$ were engaged in agriculture. What fraction less was there in agriculture in 1900 than in 1820?

123. In 1870 for every 1000 persons engaged in agriculture there were 1112 engaged in other pursuits: in 1900 for every 1000 in agriculture there were 1806 in other pursuits. Show these relations by lines, letting $\frac{1}{8}$ in. represent 100 people.

124. The average value of farms in the United States in 1900 was: total value $3574, buildings $620, implements and machinery $133, live stock $536. What per cent of the value of the land is each of the three other items given?

125. For each $1000 of total investment, how many dollars are invested in each of the other three items given?

126. For each $1000 invested in land, how much is invested in each of the other three items?

127. If 1200 cu. ins. of air is rendered unfit for breathing by one person in one minute, what volume of air will be required to last 100 persons an hour?

128. When the air is taken into the lungs (inspired), it contains 20.81% oxygen, 79.15% nitrogen, .04% carbon dioxide; when it comes out of the lungs (expired), it has 16.035% oxygen, 79.557% nitrogen, and the balance is carbon dioxide. What per cent of the oxygen is retained

in the body, and what per cent of carbon dioxide has been added?

129. If the following be the pulse rate and rate of breathing per minute, what per cent is the rate of breathing of the pulse rate for each animal?

	Pulse	Respiration
Man	70	16
Horse	36	12
Cow	55	15
Sheep	65	14
Dog	70	16

130. Compare the number of heart-beats of a man for one day with that of a horse and a cow. Compare horse with cow. Cow with sheep. Sheep with dog.

131. If the pulse (heart-beat) of a horse is 38 per minute, and that of a mule 46, and both are increased 50 % by disease, what will then be the pulse rate of each?

132. If the body temperatures of five horses are as follows, what is the average body temperature?

	7 A.M.	12 M.	5 P.M.
(1)	98.9°	99.3°	99.7°
(2)	99.6°	100°	100.3°
(3)	99.4°	99.8°	100.4°
(4)	98.8°	99.6°	100.1°
(5)	100.1°	100.3°	100.7°

133. If the body temperatures of five cows were taken as follows, what was the average temperature?

	8 A.M.	12 M.	6 P.M.
(1)	100.5°	100.8°	100.9°

(2)	99.8°	100.7°	101.2°
(3)	101.2°	101.4°	101.4°
(4)	100.8°	101.2°	101.3°
(5)	100.9°	101.3°	101.6°

134. A horse does its best work at $2\frac{1}{2}$ mis. per hour, pulling 150 lbs. It requires a pull of 8 lbs. to move 2000 lbs. on a level road on iron rails, 33 lbs. on a good pavement, 41 lbs. on a plank road, 65 lbs. on a macademized road, 150 lbs. on gravel, 237 lbs. on an ordinary road, and 457 lbs. on a loose, sandy road. How heavy a load should be given a two-horse team on each of the above roads to have the team do its best work?

135. A horse working 10 hrs. per day, and travelling at 4 mis. per hour, pulls about 63 lbs. How heavy a load should it have on each of the above roads at this rate?

136. It is estimated that a poor road costs a farmer about $15 a year for each horse. What is his loss in this way if he keeps 5 horses?

137. With hay at $15 per ton, wheat at 75 cts. a bushel, pork at 5 cts. a pound, and butter at 25 cts. a pound, what is the value of each per ton? If it costs $2.50 a ton to market produce, what per cent of the value of each of these is consumed by the cost of marketing?

138. If a man spends $\frac{2}{3}$ of a day worth $1.60 in marketing $\frac{1}{2}$ of a cord of wood worth $2.85 per cord, what is the per cent of value consumed in marketing?

139. If cotton-seed is 54% as valuable for fertilizer as cotton-seed meal, and it costs $2 a ton to haul the seed to market and haul the equivalent in meal back to the farm, how much meal should a farmer receive for 5 tons of seed,

when meal is worth $28 a ton, to justify him in exchanging seed for meal?

140. If the fare of 4 people, 96 mis., is $8.64, what will be the fare of 12 people, 48 mis.? What will be the fare of 8 people, with 4 children ($\frac{1}{2}$ fare), going 72 mis.?

141. If a pay-roll for 9 employees for 6 days is $72, how much is the pay roll for 15 employees for 9 days?

142. If it takes 8 boys, working 8 hrs. a day, 12 days to make a tennis court, how long will it take 50 boys working 2 hrs. daily?

143. If 20 men can do a certain piece of work in 7 days of 8 hrs. each, how many men will be required to accomplish the same work in 12 days of 7 hrs. each?

144. If a grain bin $4\frac{1}{2} \times 9 \times 4$ ft. holds 1262 bus. of wheat, how many bushels will a bin $4\frac{1}{3} \times 15 \times 6$ ft. hold?

145. A truck grower ships 18 baskets of beans and 27 crates of strawberries. The freight is 40 cts. a basket on the beans and the refrigerator charges 75 cts. a crate on the berries. The beans sell for $1.35 a basket and the berries for 2.87\frac{1}{2}$ a crate. How much will the grower receive for his shipment if a commission of $8\frac{1}{2}$% is charged for selling?

146. If at the Chicago stock-yards the usual charge for selling beef cattle is 50 cts. a head, what is the per cent of commission on 25 head of cattle weighing 1325 lbs. each and selling for 5.75 cts. a pound?

147. What will two cattle weighing 1225 lbs. each bring at 5\frac{3}{4}$ per hundredweight?

148. A farmer makes the following exchange with his

grocer: he gives $27\frac{1}{2}$ lbs. butter at $22\frac{1}{2}$ cts a pound, $15\frac{3}{4}$ doz. eggs at $17\frac{1}{2}$ cts. a dozen, and $3\frac{1}{3}$ bus. potatoes at 45 cts. a bushel, and receives 20 lbs. sugar at $5\frac{1}{3}$ cts. a pound, 3 lbs. cheese at $13\frac{1}{2}$ cts. a pound, and the balance in cash. How much cash does he receive?

149. If 10 lbs. of corn and 2 lbs. of cotton-seed meal a day for each horse may be substituted for 14 lbs. of corn, what will be the saving in a year on a farm where 15 horses are being fed, if corn is worth 50 cts. a bushel and cotton-seed meal $28 a ton?

150. If a 10-acre field of corn can be cut, shocked, and shredded for $4 an acre and yields 2960 lbs. of stover per acre, what is the value of the stover over the cost of harvesting the corn, if a ton of stover is worth 1200 lbs. of grass hay valued at $10 a ton?

151. If the following items represent the cost of producing an acre of potatoes, what will be the profit per acre on a yield of 235 bus. worth 47 cts. per bushel? Cost of seed $3.939, plowing $1.607, dragging 92 cts., planting 60 cts., cultivating $1.709, hoeing $2.865, spraying $3.60, digging $4.35, wear of machinery $21.24, and rent of land $5.00.

152. In Minnesota it costs as follows to cultivate an acre of corn: manuring 57.6 cts., seed 21.3 cts., shelling seed 2.3 cts., plowing $1.205, dragging 48 cts., planting 22.5 cts., cultivating $1.619, cutting 66.5 cts., shocking 52.6 cts., twine 46.7 cts., picking up ears 24.9 cts., shredding $3.794, wear of machinery $1.202, rent of land $3.50. What is the profit on 40 acres yielding 53 bus. per acre at 42 cts. a bushel, and 2964 lbs. of shredded

stover at $3.00 per ton? What is the profit on one acre?

153. If an acre of clay soil 1 ft. deep contains 6.38 tons of potash and grows a crop of 40 bus. of wheat having a ratio of weight between grain and straw of 2 : 3, how many such crops would it take to contain as much potash as there is in the soil if 1000 lbs. of wheat contain 6.3 lbs. of potash and 1000 lbs. wheat straw 5.2 lbs.?

154. The average number of marketable potatoes from each "seed" piece of several varieties was: variety No. 1, 3.14 potatoes, No. 2, 3.03 potatoes, No. 3, 3.28 potatoes, No. 4, 3.29 potatoes, No. 5, 3.48 potatoes, No. 6, 1.91 potatoes, No. 7, 1.7 potatoes. What was the average number of potatoes per seed piece of all of these varieties? By what per cent did the best exceed the poorest? By what per cent did the best exceed the average?

155. In Virginia the Burbank potato yielded 230 bus. of marketable potatoes per acre, the Crown Jewel 197 bus. What would be the difference in value of yield on 40 acres of each of these two varieties at 55 cts. per bushel?

156. Of 67 hens tested for egg laying ability for two years, 10 laid more eggs the second year than the first year, and 57 laid fewer eggs the second year. What per cent laid more the second year? What per cent laid fewer the second year?

157. A 10-acre field continuously in corn yielded 357 bus. When crimson clover was used in a rotation, the yield the year following the clover was 551 bus. What was the per cent of increase in value with corn at 48 cts. per bushel? What was the per cent of increase in bushels?

158. I buy a bill of hardware on which the list price is \$134. The discounts are 25%, 10%, and 5%. How much do I have to pay?

159. If I buy a bill of groceries on which there is a discount of 15% and 5% for cash, how much must I pay?

160. I am offered a quantity of tile for \$390 with discounts of 20% and 5% off for cash. A second firm offers me the tile at the same price with a discount of 15% and 10% off for cash. From which firm shall I buy? Why?

161. A farmer sold a team of horses for \$350 on 1 year's time. He refused an offer of \$325 cash. Did he gain or lose, and how much, by selling on time, money being worth 6%?

162. A feed merchant mixed 62 bus. of oats at 34 cts. a bushel, 1200 lbs. of wheat bran at \$18 a ton, 35 bus. of corn at 43 cts. a bushel, and 700 lbs. of cotton-seed meal at \$28 a ton. How much must he charge per 100 lbs. in order to make a profit of 20% after giving a toll of 6% by weight for grinding the oats and 5% for grinding the corn?

163. If when corn is cut and cured in the shock the loss in dry matter is 31%, and when put into the silo 11%, what is the total gain in dry matter by putting the corn from 10 A., weighing 12 T. per acre, into a silo, if, when ready for cutting, corn contains 73.2% of water? How much is the dry matter saved worth if silage containing 79.1% water has a feeding value of \$3 per ton?

164. If I buy corn at 42 cts. a bushel on 3 months' time at 6% interest, and the shrinkage in the weight of the corn

is 10%, at what price must I sell at the end of 3 months to make 20% on the transaction?

165. The interest on a mortgage for \$320 at 8% for one year is collected by an agent who receives 10% commission for collecting. What does he receive? What per cent is his commission of the principal?

166. A farmer has 1350 bus. of corn for which he is offered 37 cts. a bushel on December 1. He keeps it until March 1 and sells it for $43\frac{1}{2}$ cts. a bushel. Did he make or lose by holding the corn if it lost 8% in weight, and money was worth 8% interest?

167. If the farmer makes $12\frac{1}{2}$% profit on his wheat, the miller charges 20% for grinding it into flour, and the grocer receives 10% for selling a barrel of the flour for \$5.65, what did it cost the farmer to produce the wheat required to make a barrel of flour?

168. A man pays \$97 taxes on \$9682. What is the rate?

169. What are the taxes on \$19,862, the rate being .00971?

170. A town raises \$6859 on property assessed at \$684,936, there being 428 polls at \$1.67 each. What will be the rate?

171. A town having 248 polls, property valuation \$868,730, raises \$6482.94 taxes. What is the rate?

172. A note for \$1575 dated April 9, 1903 was indorsed as follows: Oct. 15, 1903, \$115; July 27, 1904, \$135; Jan. 21, 1905, \$325. What amount was due April 9, 1906 at 6% interest?

173. What must I pay, Sept. 17, 1907, to take up my note for $268 given Jan. 25, 1905, at 8% interest?

174. A note dated Aug. 24, 1907, secured by a mortgage, is given for $400 at 8% interest, but the money is not procured until Oct. 9, 1907. What should be the amount deducted from the first half-yearly interest because of the delay in delivering the money?

175. What are the taxes on $7682 of real and $2986 of personal property valued at $\frac{2}{3}$, rate .9%?

176. A man takes out life insurance for $3500 at 30 years of age for $19.06 a year per thousand, and pays for 20 years. If he lives to 76 years of age and money is worth 6%, what has his protection cost over and above the $3500 which his estate receives?

177. If a farmer living 15 miles from market makes a trip costing $2.50 in time, to deliver 50 lbs. of butter at 25 cts. a pound, what per cent of his receipts is consumed in cost of marketing?

178. If he delivers 650 lbs. instead, at a cost of $3 for time, what per cent of the receipts is the cost of marketing? By what per cent is the cost of marketing reduced in the second instance?

179. If it costs a strawberry grower living 5 miles from market $2 in time to deliver a 32-qt. crate of berries at $11\frac{1}{4}$ cts. per quart, what per cent of the value of the crate is consumed in marketing?

180. If he markets 20 crates at a cost of $3 in time, what per cent is so consumed?

181. If it costs the Vermont farmer $1.93 to haul

2321 lbs. of potatoes 7.1 miles, and the Connecticut farmer $2.80 to haul 2500 lbs. of potatoes 6.7 miles, how much more will it cost the Connecticut farmer to haul the crop on 9 A. yielding 268 bus. per acre 5 mis. to market than it would the Vermont farmer to haul a similar crop the same distance? How much more per acre?

182. If it costs $2.11 to haul 3020 lbs. of corn 6.6 miles in Pennsylvania and $2.76 to haul 1553 lbs. of corn 11.3 mis. in Georgia, how much more will it cost the Georgia farmer to haul the corn from 25 A., averaging 32 bus. per acre, 9 miles to market, than it will a Pennsylvania farmer to haul a similar crop the same distance?

183. If it costs 6 cts. to haul 100 lbs. of corn 6 miles to market in Ohio, and 30 cts. to haul 150 lbs. of corn 13 miles to market in Arkansas, the difference being due to better roads and larger horses in Ohio, what is the gain per acre, from good roads and large horses, to the Ohio farmer living 7 mis. from market on a crop of 42 bus. per acre? If this gain is taken to represent interest at 6 % on the increased value of the land, what is the increase in the value of the land per acre?

184. A dairyman has 2000 lbs. of milk containing 4 % of butter fat. From 1000 lbs. of this he skims the cream by the gravity settling method, which loses in the skim milk 20 % of all the butter fat. The butter fat that he does recover in this way he sells for 20 cts. per pound. He separates the cream from the other 1000 lbs. of milk with the centrifugal cream separator, which loses in the skim milk 2 % of all the butter fat. The butter fat he obtains in this way, on account of the superior quality,

he sells at 25 cts. per pound. How much greater was his profit on the 1000 lbs. of milk skimmed by the separator than on the 1000 lbs. skimmed by the gravity system?

185. If 70 gals. of milk containing 5 % of butter fat are worth $28, what is the value of 100 gallons of milk containing 3.5 % of butter fat?

186. If milk containing 5 % of butter fat is worth 10 cts. a quart, what is milk containing 3.5 % of butter fat worth?

187. I have 1000 lbs. of milk containing 3.5 % of butter fat. How much cream containing 25 % of butter fat must I add to bring it up to a 4 % butter fat standard? If I have no cream to add, how much skim milk containing no butter fat must I remove to bring it up to the standard of 4 % butter fat?

188. I have 1000 lbs. of 4.5 % milk and wish to reduce it to a 4 % standard. How much skim milk must I add? If I have no skim milk to add, how much 25 % cream can I take out of it?

189. I wish to mix cream containing 35 % of butter fat and milk containing 5 % of butter fat, so as to produce 140 lbs. of cream containing 25 % of butter fat. How many pounds of each must I use in the mixture?

190. I wish to obtain 200 lbs. of milk containing 4 % of butter fat from two lots of milk, one testing 3.8 % of butter fat and the other 4.9 % of butter fat. How many pounds of each must I use?

191. If cream containing 20 % of butter fat is worth 60 cts. per gallon, what is cream worth which contains 25 % of butter fat?

192. What is the price per pound of butter fat if cream containing 20 % of butter fat and weighing 8.3 lbs. sells for 50 cts. a gallon? At 32 cts. per pound of butter fat, what would be the price per gallon of cream containing 27 % of butter fat? Of cream containing 25 % of butter fat? 20 % of butter fat? 15 % of butter fat?

193. If 5 qts. of milk containing 3.5 % of butter fat have an energy value as food of 3066 calories, and 1 pound of round beefsteak has an energy value of 841 calories, what should round steak sell for per pound when milk is worth 8 cts. a quart? 5 cts. per quart? 10 cts. per quart?

194. A dairyman has 1000 lbs. of milk containing 5 % of butter fat. 500 lbs. of this he skims with the gravity process, and obtains a 20 % cream. He, however, loses in the skim milk 25 % of the butter fat. This skim milk he sells at 15 cts. per 100 lbs. From the remaining 500 lbs. of milk he separates the cream with the centrifugal separator, making a 50 % cream and losing but 1 % of the butter fat in the skim milk. On account of its being fresh and pure from the separator he sells this skim milk for 25 cts. per 100 lbs. How much more did the dairyman receive from his separator skim milk than from the skim milk left from the gravity skimming process?

195. The maximum amounts of fertilizer removed by various forms of farm produce is shown in the following table. Placing nitrogen at 18 cts. a pound, phosphoric acid at 6 cts., and potash at 5 cts., find the value of each of these fertilizers removed in each crop given in the table.

Produce		Pounds of		
Kind	Amount	Nitrogen	Phosphoric Acid	Potash
Corn, grain	100 bus.	100	17	19
Corn stover	3 T.	48	6	52
Oats, grain	100 bus.	66	11	16
Oat straw	$2\frac{1}{2}$ T.	31	5	52
Wheat, grain	50 bus.	71	12	13
Wheat, straw	$2\frac{1}{2}$ T.	25	4	35
Timothy hay	3 T.	72	9	71
Clover seed	4 bus.	7	2	3
Clover hay	4 T.	160	20	120
Cow-pea hay	3 T.	130	14	98
Alfalfa hay	8 T.	400	36	192
Apples	600 bus.	47	5	57
Apple leaves	4 T.	59	7	47
Apple wood growth	$\frac{1}{50}$ tree	6	2	5
Potatoes	300 bus.	63	13	90
Sugar beets	20 T.	100	18	157
Fat cattle	1000 lbs.	25	7	1
Fat hogs	1000 lbs.	18	3	1
Milk	10,000 lbs.	57	7	12
Butter	500 lbs.	1	0.2	0.1
Cotton lint	500 lbs.	1.7	.5	2.3

196. Of 4402 samples of commercial fertilizer analyzed in Indiana from 1902 to 1907, 3158 were equal in value to that guaranteed, 323 were not within 10 % of such value, and 835 were with one or more of the ingredients 20 % below the guaranteed value. What per cent was equal to the guaranteed value?

197. What per cent was not within 10 % of value? What per cent fell in the last class named?

TABLE OF ANALYSIS OF FERTILIZERS IN INDIANA

Class	1901	1902	1903	1904	1905	1906	1907
1. Number of samples collected	592	679	674	643	734	879	793
2. Number equal to guarantee in every particular	281	335	286	248	312	374	265
3. Number equal to guarantee in value	469	564	492	451	528	642	481
4. Number within 10% of guarantee . .	85	93	139	148	158	176	210
5. Number not within 10% of guarantee.	38	22	43	44	48	61	102
6. Number with one ingredient or more 20% below guarantee	103	112	138	122	148	136	177
7. Number with one ingredient or more 30% below guarantee				65	77	64	75
8. Number with one ingredient or more 50% below guarantee				21	21	25	29

What per cent of all samples analyzed in each year fell in class 2? In class 3? In class 4? In class 5? In class 6? In class 7?

198. The upper 6 ins. of soil weighs per acre 1,370,000 lbs. If the surface is cultivated thoroughly, it may contain 14.21 % of moisture; if poorly cultivated, only 8.02 %. What will be the total amount of water in the soil under poor cultivation? Under good cultivation? Obtain the last answer by two different processes.

199. In Minnesota it was found that during 10 yrs. of exclusive grain farming the per cent of nitrogen in a soil had decreased from .601 % to .523 %. If the soil to a depth of 8 ins. per acre weighs 1282 T., how much nitrogen was lost from the soil?

200. How much nitrogen will 30 bus. of wheat per acre annually take from the soil in 10 yrs., if 1 bu. of wheat takes .625 lb. nitrogen from the soil?

201. What per cent of the total nitrogen lost from the soil of problem 199 in the 10 yrs. would be taken out by wheat as in the preceding problem?

202. After 10 yrs. under a system of mixed farming, including rotation of crops, the growing of legumes, and live-stock husbandry, in another field, the nitrogen in the soil had decreased only from .31 % to .309 %. If the soil to a depth of 8 ins. weighs 58.9 lbs. per square foot of surface, how many pounds less nitrogen did this field contain after 10 yrs.? What was the difference in the loss of nitrogen per acre from this field and that of problem 199 in the 10 yrs.?

203. If it costs $29.52 to raise an acre of white pine to 40 yrs. of age, and it yields on the stump $4 per cord, what is the profit on 40 cords of box-board timber?

204. In 1871 a strip of forest land 40 mis. wide and 180 mis. long was devastated by fire. The loss is estimated at 4,000,000,000 board feet worth $10,000,000. What was the loss per square mile in board feet? In dollars?

205. If one toad destroys in 30 days 720 cutworms, 600 thousand-legged worms, 720 sow-bugs, 1080 ants, 120 weevils, 120 ground beetles, how many of each of these would 19 toads destroy? How many in a week? In 3 months? Many gardeners pay their children for killing cutworms at the rate of a penny each. What would 19 toads earn in a month at this rate? In 3 months?

206. Two boys were known to kill 19 toads. What

was the loss in 3 mos., even if it required 19 toads to do what it was shown one *could* do in the last problem?

207. Corn at different stages of growth contains dry matter (useful) and water as follows, expressed in tons:

	Corn per Acre	Water per Acre	Dry Matter per Acre
Fully tasselled	9	8.2	
Fully silked	12.9	11.3	
Kernels watery to full milk	16.3	14	
Kernels glazed	16.1	12.5	
Ripe	14.2	10.2	

Complete column of dry matter. What per cent of water and what per cent of dry matter are there at these different periods?

208. If a good clay soil contains 12,760 lbs. of potash per acre one foot deep, and a 40-bu. crop of wheat uses 35.1 lbs. of potash, how many crops will it take to use potash equal to that in the clay soil?

209. If, with the same field conditions, one variety of corn yields 7 bus. per acre more than another variety, what will be the gain in planting the better variety on 96 acres, if the poor seed costs 60 cts. per bushel and the seed of the better variety $2.50 per bushel? Allow 1 bu. of seed corn to every eight acres planted and value the corn of the crop at 49 cts. per bushel.

210. Eight bushels of clover seed containing 3 bus. of dead seed were bought at $3.50 per bushel. What was the price paid for the live seed?

211. Fifteen bushels of clover seed containing 1 bu. of

dead seed were bought at $5.50 a bushel. What was the price paid for the live seed?

212. A variety of flax, improved by seed selection, yields, on an average, 2.2 bus. per acre better than the best common varieties, which yield 15 bus. What is the per cent increase due to seed selection?

213. If it takes $6\frac{2}{3}$ hrs. to test 9 bus. of seed corn for germinating power, how long will it take to test seed enough for 600 A., allowing 1 bu. to each 5 A.?

214. A pound of cotton can be spun into 168 spools of No. 40 sewing thread, 200 yards to the spool. How many yards of thread can be spun?

215. A much finer thread can be made, of which the number of yards in the last problem equals $\frac{2}{15}$. How many miles of this fine thread can be made from a pound of cotton?

216. A still finer thread can be made, of which the number of yards in problem 214 equals only $\frac{7}{110}$. How many miles of this quality of thread can be made from a pound of cotton?

217. From one pound of cotton can be made 4 yards of bleached muslin worth 8 cts. a yard. What amount of lawn can be made from the same amount of cotton if, for every yard of bleached muslin, $2\frac{1}{2}$ yards of lawn may be made? The value of the bleached muslin is $\frac{8}{25}$ of the value of the lawn. What is the value of the lawn?

218. Four yards of sheeting can be made from a pound of cotton with a value equal to $\frac{5}{8}$ the value of the bleached muslin. What is the value of the sheeting?

219. The number of handkerchiefs that can be made from a pound of cotton is $\frac{25}{7}$ of the number of yards of calico that can be made. If the number of yards of calico is $\frac{7}{4}$ of the number of yards of bleached muslin and the price of the calico is $\frac{35}{32}$ of the price of the sheeting, how many yards of calico can be made? What is the value per yard? How many handkerchiefs can be made? What is the value of each, if one handkerchief equals $\frac{2}{5}$ the value of a yard of lawn?

220. The value of the denim that can be made from a pound of cotton bears the same ratio to the value of gingham as the number of yards of lawn to the number of handkerchiefs. $\frac{1}{4}$ as many yards of denim as gingham can be made. With gingham worth $7\frac{1}{2}$ cts. a yard, what is the denim worth per yard?

221. Arrange in tabulated form the products of a pound of cotton from the smallest quantity of material at lowest price to the most valuable product here considered.

222. An untreated loblolly pine fence post, set, costs about 14 cts. It lasts about 2 yrs. Compounding the interest at 5 per cent, what is the annual cost of such a post? If a preservative treatment, which costs 10 cts., increases the length of use of the post to 18 yrs., what is then the total cost of a post, set? What does this amount to annually, compounded as above? What is the saving due to treatment per year? Assuming that there are 200 posts to a mile of fence, what is the saving each year for a mile? This is the interest on what amount at 5 per cent?

223. The accompanying table shows the production in thousand feet of the leading kinds of lumber for 3 yrs. What was the total production for each year? What was the per cent of increase or decrease of each kind from 1899 to 1906? What the total per cent of increase or decrease?

Kind	1899	1904	1906
	M feet	*M feet*	*M feet*
Yellow pine	9,658,923	11,533,070	11,661,077
Douglas fir	1,736,507	2,928,409	4,969,843
White and Norway pine	7,742,391	5,332,704	4,583,727
Hemlock	3,420,673	3,268,787	3,537,329
Oak	4,438,027	2,902,855	2,820,393
Spruce	1,448,091	1,303,886	1,644,987
Western pine	944,185	1,279,237	1,386,777
Maple	633,466	587,558	882,878
Cypress	495,836	749,592	839,276
Poplar	1,115,242	853,554	683,132
Redwood	360,167	519,267	659,678
Red gum	285,417	523,990	453,678
Chestnut	206,688	243,537	407,379
Basswood	308,069	228.041	376,838
Birch	132,601	224,009	370,432
Cedar	232,978	223,035	357,845
Beech			275,661
Cottonwood	415,124	321,574	263,996
Elm	456,731	258,330	224,795
Ash	269,120	169,178	214,460
All others	486,848	684,526	936,555

224. A tree weighing 10,000 lbs. when dry is 50 per cent carbon. How many pounds of carbon are there in the tree?

225. Carbon dioxide being $\frac{3}{11}$ carbon, and all the carbon of the tree being derived from carbon dioxide, how many pounds of carbon dioxide are required to furnish the carbon in the tree of the last problem?

226. Air being .03$\frac{1}{3}$ % carbon dioxide, how many pounds of air are required to furnish this amount of carbon dioxide?

227. Air weighing 31.074 grs. per 100 cu. ins., how many cubic yards of air are required to furnish the amount of carbon used in the growth of the tree mentioned above?

228. There are in the atmosphere of the earth about 6,000 billion pounds of carbon dioxide. How much carbon does it contain? For how many trees like that of problem 224 would this suffice?

229. An adult exhales daily into the air about 245 g. of carbon. Estimating the earth's population at 1400 million, how much carbon is thus restored daily to the air?

230. Wood, coal, etc., in burning restore their carbon to the air. One manufacturing works thus restores from the coal burned about 5,100,000 lbs. of carbon.

A forest consisting of how many trees like the one mentioned in problem 224 would be raised from this carbon?

231. One square meter of pumpkin or sunflower leaf in a summer day of 15 hrs. makes 25 g. of starch which is $\frac{36}{81}$ carbon. How many cubic meters of air are required to furnish the requisite carbon? How long a room 3 m. wide and 3 m. high would be required to contain it?

232. Convert all the measurements of the last problem into English measure, and solve.

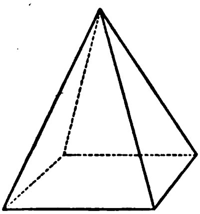
233. If Alfalfa hay contains 10.44 per cent digestible protein, 39.6 per cent carbohydrates, and 1.2 per cent fats, and red-clover hay contains 6.8 per cent protein, 35.8 per cent carbohydrates, and 1.7 per cent fats, — what is the difference in the feeding value of a ton of Alfalfa and a ton of red clover, estimating digestible protein at 3 cts. a pound, carbohydrates at 1 ct. a pound, and fats at $2\frac{1}{2}$ cts. a pound?

234. On land worth \$65 an acre Alfalfa is sowed and maintained for 4 yrs. at an expense of \$30. The cost of harvesting the hay is \$1.25 a ton; the crops are: 1st year 2.78 tons, 2d 3.15 tons, 3d 4.60 tons, 4th 4.28 tons. What is the profit on 9 acres, allowing 10 per cent interest on the value of the land, \$12 a ton for hay, and \$3 a ton for cost of baling and marketing?

APPENDIX

SURFACES OF SOLIDS

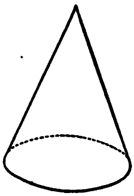
THE surface of a solid except its base or bases is called the **Lateral Surface.** The **Entire Surface** includes its bases.



A solid, the base of which is a polygon and the sides of which are triangles meeting at a point or vertex, is called a **Pyramid.**

The distance from the vertex to the side of the base is called the **Slant Height.** If the sides and angles of the pyramid are respectively equal and the apex is directly over the centre of the base, the pyramid is said to be **regular.**

The surface of a pyramid, as may be seen, is composed of a number of triangles with an altitude equal to the slant height of the pyramid and the bases forming the perimeter of the solid.



A solid, the base of which is a circle, and the surface of which tapers to a point or vertex, is called a **Cone.**

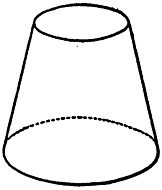
The lateral surface of a cone may be assumed to be made up of a number of infinitely small triangles.

Hence, to find the lateral surface of a pyramid or cone, multiply the perimeter of the base by $\frac{1}{2}$ the slant height.

The portion remaining after a part of the top has been cut from a pyramid or cone is called a **Frustum** of a pyramid or of a cone.

The lateral surface of a frustum of a pyramid may be regarded as composed of a number of trapezoids, the sum of the parallel sides of which forms the perimeter of the

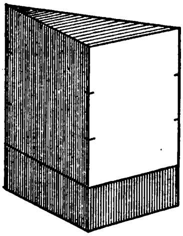
bases and the slant height of which equals the altitude of the frustum.



The lateral surface of a frustum of a cone may be considered as made of a number of infinitely narrow trapezoids.

To find the lateral surface of the frustum of a pyramid or of a cone, multiply half the sum of the perimeters of the two bases by the slant height.

A solid having equal polygons parallel to each other for its two ends and parallelograms for its sides is a **Prism.**



From the form of their bases, prisms are triangular, quadrangular, etc.

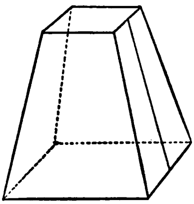
The lateral surface of a prism may be regarded as a series of parallelograms, with their combined bases equal to the perimeter of the two bases of the prism and a height equal to the altitude of the prism.

To find the lateral surface of a prism, multiply the perimeter of the base by the altitude.

VOLUMES OF SOLIDS

The volume of a solid is the number of solid units it contains.

To find the volume of a prism, multiply the area of the base by the altitude.



A square prism has three times the solid contents of a pyramid. In like manner, the cylinder has three times the solid contents of the cone.

To find the volume of a pyramid or cone, multiply the area of the base by one-third the altitude.

The frustum of a pyramid or cone is equal to three pyramids or cones, the common altitude of which is the altitude of the frustum and the bases of which are the

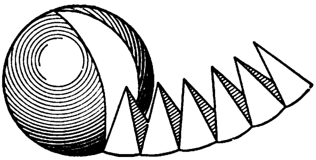
upper base, the lower base, and a mean proportional between them.

Hence, to find the volume of a frustum of a pyramid or cone, add to the sum of the areas of the two ends, the square root of the product of these areas, and multiply the result by one-third of the altitude.

A solid, bounded by a curved surface, every point of which is equally distant from the point within, called the centre, is a **Sphere.**

The **Diameter** of a sphere passes through the centre and terminates at the circumference.

One-half the diameter is the **Radius.** The circumference of the circle, the radius of which is the radius of the sphere, is the **Circumference** of the sphere.



The surface of a sphere is equal to the square of the diameter of the sphere multiplied by 3.1416.

A sphere may be regarded as composed of pyramids, the bases of which form the surface of the sphere and the altitudes of which equal the radius of the sphere.

Hence, to find the volume of a sphere, multiply the surface by one-third the radius, or multiply the cube of the diameter by .5236.

THE EXTRACTION OF THE CUBE ROOT

Rule.

1. Beginning at units, separate the number into groups of three figures each.
2. Find the greatest cube contained in the left-hand group. Write its cube root as the first figure of the required root.
3. Subtract this cube from the first period, and bring down the next period.
4. Divide the number so found by three times the

square of the root already found, considered as tens, as a trial divisor, to find the next figure of the root.

5. To this trial divisor add three times the product of the two parts of the root plus the square of the second part of the root, to make the complete divisor.

6. Multiply the complete divisor by the second figure of the root; subtract and bring down the next period.

7. Continue in a similar way until all periods have been used.

For example, to find the cube root of 242,970,624, proceed according to the rule as follows:

		242'970'624(624	required root
		216	cube of 1st figure of root
1st trial divisor	10800	26970	
$3 \times (60 \times 2)$	360	22328	product of 2d figure of root with 1st complete divisor.
2^2	4		
1st complete divisor	11164		
2d trial divisor	1153200	4642624	
$3 \times (620 \times 4)$	7440	4642624	product of 3d figure of root with 2d complete divisor.
4^2	16		
2d complete divisor	1160656		

1. Separate into periods.

2. We find by inspection or trial that the cube of 6 is the largest cube contained in the first period, 242. 6 is put down as the first figure of the root.

3. Subtracting the cube of 6, 216, from the first period, 242, we have 26; bringing down the next period, we have 26,970.

4. The root already found considered as tens is 60. The square of this is 3600; three times this is 10,800, the trial divisor. This trial divisor, 10,800, is contained in the dividend, 26,970, two times. 2 is, therefore, set down as the next figure of the root.

5. The two parts of the root already found are 60 and 2. The product of 60×2 is 120; three times this is 360. The square of the last figure found is 4. Adding 360 plus 4 to the trial divisor, we have the complete divisor 11,164.

6. Multiplying the complete divisor by the second figure of the required root and subtracting, we have 4642. Bring down the next group, 624, giving 4,642,624 for the next dividend.

7. Proceeding as before:

The root already found is 62 or, considered as tens, is 620. The square of this is 384,400. This multiplied by 3 is 1,153,200, the trial divisor. This trial divisor is contained 4 times in the dividend. 4 is, therefore, set down as the next figure of the root.

The two parts of the root already found are 620 and 4. Their product is 2480; three times this is 7440. Adding this together with the square of the last number of the root, which is 16, to the trial divisor, we have the complete divisor 1,160,656.

Multiplying this complete divisor by the last figure found, we have 4,642,624, completing the problem.

The cube root of 242,970,624 is 624.

If the number of which the cube root is to be extracted has decimal places, divide the figures at both sides of the decimal point into periods of three figures each, annexing ciphers to the last period of the decimal, if need be, to give three figures.

There are as many decimal places in the cube root of a decimal as there are periods of three figures each in the decimal.

If the number is not a perfect cube, annex ciphers and continue the process to as many decimal places as may be desired.

The cube root of a fraction is found by taking the cube root of its numerator and of its denominator, or by reducing the fraction to a decimal and then extracting the root.

PROOF OF THE FUNDAMENTAL PROCESSES BY CASTING OUT NINES

Addition.

Add:

$$\begin{array}{r r}
71287 & 7 \\
67328 & 8 \\
79816 & 4 \\
42983 & 8 \\
\underline{54631} & \underline{1} \\
316045 & 1
\end{array}\left.\vphantom{\begin{array}{c}1\\1\\1\\1\\1\\1\end{array}}\right\}\text{Add.}$$

To test accuracy of the addition, cast out the nines from each row and from the sum, setting down the remainders. Thus in the first row drop 7 + 2, 8 + 1, set down 7; second

row drop 6 + 3 and 7 + 2, set down 8; third row drop 9 and 8 + 1, add 7 + 6 = 13, drop 9 from 13, leaving 4, set down 4; fourth line drop 4 + 2 + 3, drop 9, set down 8; fifth line drop 5 + 4 and 6 + 3, set down 1. From sum drop 6 + 3, 5 + 4, set down 1. Add the numbers set down from the first five numbers, cast out 8 + 1, add 4 + 8 + 7 = 19, cast out 2 × 9, leaving 1. The number remaining being 1 in both cases, the work is presumably correct.

Subtraction.

Subtract:

$$\begin{array}{r} 3726813 \\ \underline{2619832} \\ 1106981 \end{array} \qquad \left.\begin{array}{r} 3 \\ \underline{4} \\ 8 \end{array}\right\} \text{Subtract.}$$

Cast out the nines from both minuend and subtrahend; subtract the number remaining from the subtrahend from that remaining from the minuend, restoring one of the nines cast out, if need be, in order to subtract. If the work is correct, the number so found should equal the number left after casting nines from the remainder.

Multiplication.

Multiply:

$$\begin{array}{r} 643 \\ \underline{249} \\ 5787 \\ 2572 \\ \underline{1286} \\ 160107 \end{array} \qquad \begin{array}{r} \left.\begin{array}{r} 4 \\ \underline{6} \end{array}\right\} \text{Multiply.} \\ 24\phantom{\text{Multiply.}} \\ \\ \\ \\ 6\phantom{\text{Multiply.}} \end{array}$$

Cast nines from multiplier and multiplicand. Find the product of the numbers remaining, and cast nines from it. The number then remaining should equal the number left after casting nines from the product.

ARITHMETICAL PROGRESSION

An **Arithmetical Progression** is a series of numbers which increase or decrease by a common and constant difference, *e.g.*, 4, 8, 12, 16, 20, 24, etc., the **common difference** here being 4.

The numbers of the series are called its **Terms**.

To find any term of an arithmetical progression, multiply the common difference by a number one less than the required term; add this product to the first term if the series is increasing; subtract this product from the first term if the series is decreasing.

Find the 17th term of the series 7, 14, 21 ——.

$16 \times 7 = 112. \qquad 112 + 7 = 119.$

Find the 12th term of the series 217, 213, 209 ——.

$11 \times 4 = 44. \qquad 217 - 44 = 173.$

To find the sum of the terms of an arithmetical progression, multiply the number of terms by the sum of the first and last terms and divide by two.

What is the sum of the first 10 terms of the series 2, 4, 6 ——?

$9 \times 2 = 18. \qquad 18 + 20 = \text{last term.}$

$$\frac{(2 + 20) \times 10}{2} = 110 = \text{sum of the terms.}$$

GEOMETRICAL PROGRESSION

A **Geometrical Progression** is a series of numbers in which any term is equal to the product of the preceding term and a **constant factor**, *e.g.*, 2, 4, 8, 16, 32, 64 ——.

To find any term of a geometrical progression, raise the constant factor to a power one less than the number of the required term, and multiply by the first term.

Find the 6th term, of the series 1, 2, 4, 8 ——.

The constant factor 2 to the fifth power = 32.

$32 \times 1 = 32.$ *Ans.*

To find the sum of the terms of a geometrical progression, multiply the last term by the constant factor; subtract the first term and divide by the constant factor, minus 1.

Find the sum of the series 1, 2, 4, 8 —— to and including the 6th term.

The last term = 32. The constant factor = 2.

$32 \times 2 = 64. \qquad 64 - 1 = 63. \qquad 63 \div 1 = 63.$ *Ans.*

If the progression is decreasing, **subtract** the product from the first term.

TABLES OF MEASURES

LENGTH

12	inches (ins.)	=	1 foot (ft.)
3	feet	=	1 yard (yd.)
$16\frac{1}{2}$	feet, or $5\frac{1}{2}$ yards	=	1 rod (rd.)
320	rods	=	1 mile (mi.)

mis.	rds.	yds.	ft.	ins.
1 =	320 =	1760 =	5280 =	63,360
	1 =	$5\frac{1}{2}$ =	$16\frac{1}{2}$ =	198
		1 =	3 =	36
			1 =	12

3 barleycorns	= 1 inch, used by shoemakers.
18 inches	= 1 common cubit.
21.888 inches	= 1 sacred cubit.
4 inches	= 1 hand, used to measure the height of horses.
9 inches	= 1 span.
6 feet	= 1 fathom, used to measure depths at sea.
3 feet	= 1 pace, used in pacing distances.
$5\frac{1}{2}$ paces	= 1 rod, used in pacing distances.
8 furlongs	= 1 mile.
1.15 statute miles	= 1 geographical nautical mile or knot.
3 geographical miles	= 1 league.
60 geographical miles, 69.16 statute miles	= 1 degree of latitude on a meridian, or of longitude on the equator.

The length of a degree of latitude is commonly regarded as 69.16 miles, and is that adopted by the United States Coast Survey.

ANGULAR MEASURE

60 seconds (″)	= 1 minute (′)
60 minutes	= 1 degree (°)
360 degrees	= 1 circumference

SURFACE OR SQUARE MEASURE

144 square inches (sq. ins.)	= 1 square foot (sq. ft.)
9 square feet	= 1 square yard (sq. yd.)
30¼ square yards	= 1 square rod (sq. rd.)
160 square rods	= 1 acre (A.)
640 acres	= 1 square mile (sq. mi.)
1 square mile	= 1 section
36 square miles	= 1 township

sq. mis.		A.		sq. rds.		sq. yds.		sq. ft.
1	=	640	=	102,400	=	3,097,600	=	27,878,400
		1	=	1600	=	4840	=	43,560
				1	=	30¼	=	272¼

100 square feet = 1 square (in roofs, floors, etc.)

SOLID OR CUBIC MEASURE

1728 cubic inches (cu. ins.)	= 1 cubic foot (cu. ft.)
27 cubic feet	= 1 cubic yard (cu. yd.)

cu. yd.		cu. ft.		cu. ins.
1	=	27	=	46,656

WOOD MEASURE

16 cubic feet = 1 cord foot (cd. ft.)

128 cubic feet, 8 cord feet = 1 cord (cd.)

CAPACITY

Liquid Measure

4 gills (gi.)	= 1 pint (pt.)
2 pints	= 1 quart (qt.)
4 quarts	= 1 gallon (gal.)

gal.		qts.		pts.		gis.
1	=	4	=	8	=	32
		1	=	2	=	8

1 gallon = 231 cu. ins.

DRY MEASURE

2 pints	= 1 quart
8 quarts	= 1 peck (pk.)
4 pecks	= 1 bushel (bu.)
2.5 bushels	= 1 barrel (bbl.)

bbl.		bus.		pks.		qts.		pts.
1	=	$2\frac{1}{2}$	=	10	=	80	=	160
		1	=	4	=	32	=	64
				1	=	8	=	16

1 bushel = 2150.42 cu. ins.
1 heaped bu. = $1\frac{1}{4}$ bus.

WEIGHT

Avoirdupois Weight

16 drams	= 1 ounce (oz.)
16 ounces	= 1 pound (lb.)
100 pounds	= 1 hundredweight (cwt.)
2000 pounds	= 1 ton (T.) (short)
2240 pounds	= 1 long ton

T.		cwts.		lbs.		ozs.
1	=	20	=	2000	=	32,000
		1	=	100	=	1600

The following denominations are used in Avoirdupois Weight:

14 lbs.	= 1 stone
100 lbs. butter	= 1 firkin
100 lbs. grain or flour	= 1 cental
100 lbs. dried fish	= 1 quintal
100 lbs. nails	= 1 keg
196 lbs. flour	= 1 barrel
200 lbs. pork or beef	= 1 barrel
230 lbs. salt at N.Y. works	= 1 barrel

WEIGHTS OF PRODUCE

The following are minimum weights per bushel of certain articles of produce according to the laws of various States:

Wheat	60 lbs.
Corn in the ear	70 lbs., except in Miss., 72 lbs.; in Ohio, 68 lbs.; in Ind. after Dec. 1, and in Ky. after May 1, following the time of husking, it is 68 lbs.
Corn shelled	56 lbs., except in Cal., 52 lbs.
Rye	56 lbs., except in Cal., 54 lbs.; in La., 32 lbs.
Buckwheat	48 lbs., except in Cal., 40 lbs.; Ky., 56 lbs.; Ida., N.D., Okl., Ore., S.D., Tex., Wash., 42 lbs.; Kan., Minn., N.C., N.J., Ohio, Tenn., 50 lbs.
Barley	48 lbs., except in Ore., 46 lbs.; Ala., Ga., Ky., Pa., 47 lbs.; Cal., 50 lbs.; La., 32 lbs.
Oats	32 lbs. except in Ida., and Ore., 36 lbs.; in Md., 26 lbs.; in N.J. and Va., 30 lbs.
Peas	60 lbs.
White beans	60 lbs.
White potatoes	60 lbs., except in Md., Pa., Va., 56 lbs.
Sweet potatoes	55 lbs.
Onions	57 lbs.
Turnips	55 lbs.
Dried peaches	33 lbs.
Dried apples	26 lbs.
Clover seed	60 lbs., except in N.J., 64 lbs.
Flax seed	56 lbs.
Millet seed	50 lbs.
Hungarian grass seed	50 lbs.
Timothy seed	45 lbs., except in Ark., 60 lbs.; N.D., 42 lbs.

Blue grass seed	44 lbs.
Hemp seed	44 lbs.
Corn meal	50 lbs., except in Ala., Ark., Ga., Ill., Miss., N.C., Tenn., 48 lbs.
Bran	20 lbs.

TROY WEIGHT

For Precious Metals, Jewels, etc.

24 grains	= 1 pennyweight (pwt.)
20 pennyweights	= 1 ounce
12 ounces	= 1 pound

$$\left.\begin{array}{r l} 437\frac{1}{2} & \text{grains} = 1 \text{ ounce} \\ 7000 & \text{grains} = 1 \text{ pound} \end{array}\right\} \text{Av.}$$

$$\left.\begin{array}{r l} 480 & \text{grains} = 1 \text{ ounce} \\ 5760 & \text{grains} = 1 \text{ pound} \end{array}\right\} \text{Troy}$$

APOTHECARIES' WEIGHT

20 grains	= 1 scruple (sc. or ℈)
3 scruples	= 1 dram (dr. or ʒ)
8 drams	= 1 ounce (oz. or ℥)
12 ounces / 5760 grains	= 1 pound (lb. or ℔)

APOTHECARIES' LIQUID MEASURE

60 minims	= 1 fluid dram (fʒ)
8 fluid drams	= 1 fluid ounce (f℥)
16 fluid ounces	= 1 pint (O.)
8 pints	= 1 gallon (cong.)

COUNTING

12 things	= 1 dozen (doz.)
12 dozen	= 1 gross (gro.)
12 gross	= 1 great gross (G. gr.)
20 things	= 1 score

24 sheets (paper)	= 1 quire
20 quires, or 480 sheets	= 1 ream

TIME

60 seconds (secs.)	= 1 minute (min.)
60 minutes	= 1 hour (hr.)
24 hours	= 1 day (da.)
7 days	= 1 week (wk.)
2 weeks	= 1 fortnight
30 (31, 28, 29) days	= 1 month (mo.)
3 months, or 13 weeks	= 1 quarter
12 months, or 365 days	= 1 year (yr.) (common)
365 days 5 hrs. 48 mins. 49.7 secs.	= 1 true or solar year
366 days	= 1 leap year
10 years	= 1 decade
100 years	= 1 century (C.)

VALUE

U. S. Money

10 mills	= 1 ct. (ct., c., or ¢)
10 cents	= 1 dime (di.)
100 cents or 10 dimes	= 1 dollar ($)
10 dollars	= 1 eagle

Canadian Money

100 cents = 1 dollar = $1

English Money

12 pence (*d.*)	= 1 shilling (*s.*)	= $0.243+
20 shillings	= 1 pound (£)	= $4.8665

French Money

100 centimes = 1 franc (fr.) = $0.193

German Money

100 pfennigs = 1 mark (M.) = $0.238

Russian Money

100 copecks = 1 ruble

Austro-Hungarian Money

100 kreutzer = 1 florin

VALUE OF FOREIGN COINS IN UNITED STATES MONEY

(Proclaimed by the Secretary of the Treasury)

Country	Money Unit	Value in United States
Austria-Hungary . .	Crown	\$ .203
Belgium	Franc	.193
Brazil	Milreis	.546
Canada	Dollar	1.00
Central America . .	Peso	.485
Chile	Peso	.365
China	Teal	.72 to .80
Denmark	Crown	.268
Ecuador	Sucre	.487
Egypt	Pound = 100 piasters	4.943
France	Franc	.193
Germany	Mark	.238
Great Britain . . .	Pound	4.8665
Greece	Drachma	.193
Hayti	Gourde	.965
India	Pound	4.8665
Italy	Lira	.193
Japan	Yen	.498
Mexico	Peso	.498
Netherlands	Florin	.402
Norway	Crown	.268
Panama	Balboa	1.00
Peru	Libra	4.8665
Portugal	Milreis	1.08
Russia	Ruble	.515
Spain	Peseta	.193
Sweden	Crown	.268
Switzerland	Franc	.193
Turkey	Piaster	.044

NEGOTIABLE PAPERS

States and Territories	Interest Laws			Statutes of Limitation		
	Legal Rate	Maximum Contract Rate	Grace	Judgments	Notes	Open Accounts
				Years	*Years*	*Years*
Alabama	8	8	G	20	6	3
Arkansas	6	10	G	10	5	3
Arizona	6	Any	G	5	4	3
California	7	Any		5	4	2
Colorado	8	Any		20	6	6
Connecticut	6	6				6
Delaware	6	6			6	3
District of Columbia	6	10		12	3	3
Florida	8	10		20	5	2
Georgia	7	8	G	7	6	4
Idaho	7	12		6	5	4
Illinois	5	7		20	10	5
Indiana	6	8	G	20	10	6
Iowa	6	8	G	20	10	5
Kansas	6	10	G	5	5	3
Kentucky	6	6	G	15	15	5
Louisiana	5	8	G	10	5	3
Maine	6	Any		20	6	6
Maryland	6	6		12	3	3
Massachusetts	6	Any		20	6	6
Michigan	5	7	G	10	6	6
Minnesota	7	10	G	10	6	6
Mississippi	6	10	G	7	6	3
Missouri	6	8	G	10	10	5
Montana	8	Any		10	8	5
Nebraska	7	10	G	5	5	4
Nevada	7	Any	G	6	4	4
New Hampshire	6	6		20	6	6
New Jersey	6	6		20	6	6
New Mexico	6	12	G	7	6	4
New York	6	6		20	6	6
North Carolina	6	6	G	10	3	3
North Dakota	7	12		10	6	6
Ohio	6	8		15	15	6
Oklahoma	7	12	G	5	5	3
Oregon	6	10		10	6	6
Pennsylvania	6	6		5	6	6
Rhode Island	6	Any		20	6	6
South Carolina	7	8	G	20	6	6
South Dakota	7	12	G	10	6	6
Tennessee	6	6		10	6	6
Texas	6	10	G	10	4	2
Utah	8	Any		8	6	4
Vermont	6	6		8	6	6
Virginia	6	6		20	5	2
Washington	6	12		6	6	3
West Virginia	6	6		10	10	5
Wisconsin	6	10		20	6	6
Wyoming	8	12	G	21	5	8

TABLE OF COMPOUND INTEREST

Periods	¾ Per Cent	1 Per Cent	1¼ Per Cent	1½ Per Cent	2 Per Cent
1	1.00750000	1.01000000	1.01250000	1.015000	1.020000
2	1.01505625	1.02010000	1.02515625	1.030225	1.040400
3	1.02266917	1.03030100	1.03797070	1.045678	1.061208
4	1.03033919	1.04060401	1.05094533	1.061364	1.082432
5	1.03806673	1.05101005	1.06408215	1.077284	1.104081
6	1.04585223	1.06152015	1.07738318	1.093443	1.126162
7	1.05369612	1.07213535	1.09085047	1.109845	1.148686
8	1.06159884	1.08285670	1.10448610	1.126493	1.171660
9	1.06956083	1.09368527	1.11829217	1.143390	1.195093
10	1.07758254	1.10462212	1.13227082	1.160541	1.218994
11	1.08566441	1.11566834	1.14642421	1.177949	1.243374
12	1.09380689	1.12682503	1.16075451	1.195618	1.268242
13	1.10301044	1.13809328	1.17526389	1.213552	1.293607
14	1.11027552	1.14947421	1.18995469	1.231756	1.319479
15	1.11860259	1.16096895	1.20482913	1.250232	1.345868
16	1.12699211	1.17257864	1.21988949	1.268985	1.372786
17	1.13544455	1.18430443	1.23513811	1.288020	1.400241
18	1.14396038	1.19614747	1.25047734	1.307341	1.428246
19	1.15254009	1.20810895	1.26610830	1.326951	1.456811
20	1.16118414	1.22019003	1.28193466	1.346855	1.485947

Periods	2½ Per Cent	3 Per Cent	3½ Per Cent	4 Per Cent	5 Per Cent	6 Per Cent
1	1.025000	1.030000	1.035000	1.040000	1.050000	1.060000
2	1.050625	1.060900	1.071225	1.081600	1.102500	1.123600
3	1.076891	1.092727	1.108718	1.124864	1.157625	1.191016
4	1.103813	1.125509	1.147523	1.169859	1.215506	1.262477
5	1.131408	1.159274	1.187686	1.216653	1.276282	1.338226
6	1.159693	1.194052	1.229255	1.265319	1.340096	1.418519
7	1.188686	1.229874	1.272279	1.315932	1.407100	1.503630
8	1.218403	1.266770	1.316809	1.368569	1.477455	1.593848
9	1.248863	1.304773	1.362897	1.423312	1.551328	1.689479
10	1.280085	1.343916	1.410599	1.480244	1.628895	1.790848
11	1.312087	1.384234	1.459970	1.539454	1.710339	1.898299
12	1.344889	1.425761	1.511069	1.601032	1.795856	2.012197
13	1.378511	1.468534	1.563956	1.665074	1.885649	2.132928
14	1.412774	1.512590	1.618695	1.731676	1.979932	2.260904
15	1.448298	1.557967	1.675349	1.800944	2.078928	2.396558
16	1.484506	1.604706	1.733986	1.872981	2.182875	2.540352
17	1.521618	1.652848	1.794676	1.947901	2.292018	2.692773
18	1.559659	1.702433	1.857489	2.025817	2.406619	2.854339
19	1.598650	1.753506	1.922501	2.106849	2.526950	3.025600
20	1.638616	1.806111	1.989789	2.191123	2.653298	3.207136

METRIC TABLES

MEASURES OF LENGTH

10 millimeters (mm.)	= 1 centimeter (cm.)
10 centimeters	= 1 decimeter (dm.)
10 decimeters	= 1 meter (m.)
10 meters	= 1 dekameter (Dm.)
10 dekameters	= 1 hektometer (Hm.)
10 hektometers	= 1 kilometer (Km.)
20 kilometers	= 1 myriameter (Mm.)

MEASURES OF SURFACE

100 sq. millimeters (sq. mm.)	= 1 sq. centimeter (sq. cm.)
100 sq. centimeters	= 1 sq. decimeter (sq. dm.)
100 sq. decimeters	= 1 sq. meter (sq. m.)
100 sq. meters	= 1 sq. dekameter (sq. Dm.)
100 sq. dekameters	= 1 sq. hektometer (sq. Hm.)
100 sq. hektometers	= 1 sq. kilometer (sq. Km.)

MEASURES OF VOLUME

1000 cu. millimeters (cu. mm.)	= 1 cu. centimeter (cc.)
1000 cu. centimeters	= 1 cu. decimeter (cu. dm.)
1000 cu. decimeters	= 1 cu. meter (cu. m.)

MEASURES OF CAPACITY

10 milliliters (ml.)	= 1 centiliter (cl.)
10 centiliters	= 1 deciliter (dl.)
10 deciliters	= 1 liter (l.)
10 liters	= 1 Dekaliter (Dl.)
10 dekaliters	= 1 Hektoliter (Hl.)
10 hektoliters	= 1 Kiloliter (Kl.)

MEASURES OF WEIGHT

10 milligrams (mg.)	=	1 centigram (cg.)
10 centigrams	=	1 decigram (dg.)
10 decigrams	=	1 gram (g.)
10 grams	=	1 dekagram (Dg.)
10 dekagrams	=	1 hektogram (Hg.)
10 hektograms	=	1 kilogram (K.)
10 kilograms	=	1 myriagram (Mg.)
10 myriagrams	=	1 quintal (q.)
10 quintals	=	1 tonneau (T.)

METRIC EQUIVALENTS OF ENGLISH MEASURES

1 acre = .4047 hectare.
1 bushel = 35.24 liters.
1 cubic foot = 28.316 liters.
1 cubic inch = 16.39 cubic centimeters.
1 cubic yard = .7645 cubic meter.
1 foot = 30.48 centimeters.
1 gallon = 3.785 liters.
1 grain = .0648 gram.
1 inch = 25.4 millimeters.
1 mile = 1.609 kilometers.
1 ounce (avoirdupois) = 28.35 grams.
1 ounce (Troy) = 31.1 grams.
1 peck = 8.809 liters.
1 pint = .4732 liter.
1 pound = .4536 kilo.
1 quart (dry) = 1.101 liters.
1 quart (liquid) = .9464 liter.
1 square foot = .0929 square meter.
1 square inch = 6.452 square centimeters.
1 square yard = .8361 square meter.
1 ton (2000 lbs.) = .9072 metric ton.
1 ton (2240 lbs.) = 1.017 metric tons.
1 yard = .9144 meter.

ENGLISH EQUIVALENTS OF METRIC MEASURES

1 centimeter = .3937 inch.
1 cubic centimeter = .061 cubic inch.
1 cubic meter = 35.31 cubic feet, or 1.308 cubic yards.
1 gram = 15.43 grains.
1 hectare = 2.471 acres.
1 kilo = 2.205 pounds.
1 kilometer = .6214 mile.
1 liter = .9081 dry quart, or 1.051 liquid quarts.
1 meter = 3.281 feet.
1 millimeter = .0394 inch.
1 square centimeter = .155 square inch.
1 square meter = 1.196 square yards, or 10.76 square feet.
1 metric ton = 1.102 short tons, or .9842 long ton.

CATTLEMEN'S NOTATION

Explanation of the Value of the Various Notches.

A notch in *bottom of the animal's left* ear equals 1, two notches equal 2.

A notch in *top of left* ear equals 3, two notches equal 6, three notches equal 9.

A notch in *bottom of right* ear equals 10, two notches equal 20.

A notch in *top of right* ear equals 30, two notches equal 60, three notches equal 90.

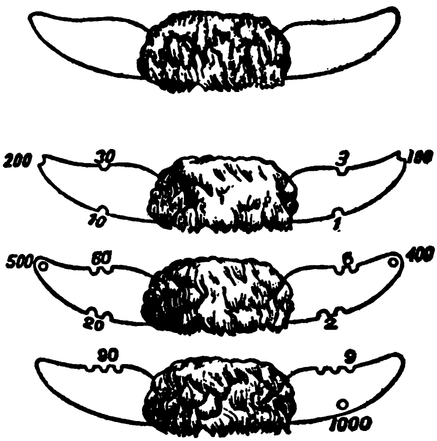
A notch in *end of left* ear equals 100.

A notch in *end of right* ear equals 200.

A hole in *end of left* ear equals 400.

A hole in *end of right* ear equals 500.

A hole in *bottom of left* ear equals 1000.



Numbers can thus be made from 1 to 1999.

LUMBERMEN'S NOTATION

In marking lumber the following characters are used: